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CROP AND SOIL.

The series of reviews upon which we have been engaged have had for their object the examination of experiments planned to determine the influence of the principal manurial ingredients upon certain plantation products. Money is wasted if a greater quantity of a particular ingredient is applied than the plant requires, even though other ingredients are present in full measure ; and the best value for money is not being obtained if an excess is applied of one ingredient at the expense of another more especially in demand by the plant. Every planter should be able to say approximately what percentage of nitrogen, phosphoric acid and potash a manure should contain for his crop and soil. Such a formula exists for each crop and soil could it be ascertained, and any variation from it involves unremunerative expenditure. It can never be accurately ascertained because it is practically impossible for each man to carry out the necessary experiments which require for their proper conduct special training and equipment not always available. But it will be possible approximately to ascertain it when experiments in the field now being conducted in Ceylon and other countries have been continued for a period of time sufficient to allow of conclusions being drawn ; and those conclusions are studied by each planter in the light of his soil requirements. These can to a great extent be obtained by soil analysis but not wholly so, because soil analysis does not tell us definitely what proportion of the plant food present is in the form that the crop requires for its use. The only way to find this out is by actually growing the crop upon the soil.

This, of course, is very far from stating the whole of the case for, as Hall has truly said,* agricultural science involves some of the most complex and difficult problems the world is ever likely to have to solve. We can to a great extent determine the materials with which Nature's great laboratory, the soil, is furnished; but we cannot observe that laboratory, nor yet the plant, at work.

Other considerations tending to modify a system of manuring will arise. For example, the rubber planter is confronted with the problem of the extent to which he is able to lighten the manure bill by judicious spacing and thinning out, and it is a problem of some difficulty. Plant food is absorbed from the soil in solution and carried by the water to the leaves in which are the organs of transpiration. Generally speaking, the amount of moisture taken up by the roots will depend upon the volume transpired by the leaves. Hence the planter by promoting leaf growth enables the tree to reach stores of plant food in the soil that might otherwise be inaccessible to it, increasing at the same time the capacity of the tree for collecting from the atmosphere carbon, its staff of life. To solve the problem it is first necessary for him to determine approximately the air room a Hevea tree would demand if allowed to develop its canopy unhampered and then to reconcile that demand with the necessity of making the utmost of his acres. The solution will be different in different localities and will not be the same for steep hill-sides as for flat land.

The problem of the coconut planter is of a somewhat different character. The coconut palm does not branch, and the space it should be allowed can soon be ascertained by local observation. But the tree has a wider range of climate than Hevea and is planted in regions where the critical question is one not of spacing but of water supply. In a locality with a long dry season the problem of the coconut planter with limited means at his disposal may be stated thus: Will it not pay me better to devote the whole or part of the money now expended in manures to cultivating the land in such a way that water that has fallen in the rainy season may as far as possible be conserved for the use of the trees in the dry season? In many cases we believe it would be found that the claims of water came first.

R. N. L.

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* The Book of the Rothamsted Experiments.

RUBBER.

RECENT DATA ON RUBBER PLANTATIONS.

The area under rubber in 1913 is estimated at 1,250,000 acres ; distributed as follows :—

Malaya, etc.	...	...	500,000 acres.
Java	...	...	150,000 ,,
Sumatra, etc.	...	...	250,000 ,,
Ceylon	...	...	220,000 ,,
India and Burma	...	...	50,000 ,,
German Colonies	...	...	60,000 ,,
Borneo	...	...	20,000 ,,

In 1910 the total acreage under rubber was 767,000 acres ; in 1911, 865,000 and in 1912, 987,000. It will thus be seen that the increase shown by 1913 over 1912 is about 27 per cent.

The following table shows the relative importance of the rubber acreage in various parts of the Malayan peninsula :—

	1912 Acreage.	1913 Acreage.	1913 Output in tons.
Federated Malay States	399,197	433,324	21,229
Straits Settlements	94,263	111,316	6,047
Johore ...	91,827	117,022	1,646
Kelantan and Kedah	34,837	45,373	246
Trengannu ...	1,497	1,510	Not yet producing
	621,621	708,545	29,168

In 1912 there were in all 235,912 workers employed on Malayan estates.

The production of rubber in India is confined to Assam, Burma, and the Madras Presidency, which exported in the fiscal years ending March 31, 1913 and 1914, 14,627 and 23,264 cwt. respectively. The acreage under rubber and the number of trees in 1913 were as follows—

	Acres.	No. of trees.
Assam ...	4,681	137,430
Madras ...	12,022	1,636,476
Burma ...	29,544	4,911,399

The yield of the Assam plantations is relatively small and the number of trees to the acre much less than in Madras and Burma. In 1913 the outturn of Madras was still more than double that of Burma, because most of the trees in Burma, being less than six years old, are not yet productive.

In 1914 the total acreage under rubber cultivation was about 34,000 acres. The rubber growing districts are in Lower Burma, including Tenasserim. The soil is principally a reddish-yellow, friable sandy loam, with occasional districts which have a subsoil of laterite. The land is easily drainable. It is slightly undulating, and in nearly all cases is protected from the South-west monsoon by high ranges of hills.

The rainfall varies slightly in different districts, from 110 inches in North Tenasserim to 200 in Tavoy. There are two seasons: December to April, the dry or cold season, and May to November, the wet or monsoon season. The driest months are February and March, when there is very little or no rain, but there are heavy mists and dews which compensate for the lack of rain. The temperature is about 88.8° F. in the daytime and 74° F. at night—the mean temperature for the year being 80° F.

All planting is stump planting, about 9 to 12 months old. The plants attain a height of from 10 to 12 feet and a girth average of $2\frac{1}{2}$ to 4 inches in one year. All the trees can be tapped in 4 years from the date of planting, the girth average three feet from the ground being 18 to 24 inches and more if planted 20 × 20 feet. The average yield for 4 to 6 year old trees is $1\frac{1}{2}$ to 3 lb. per tree per year. The rubber is of excellent quality. Tapping can be done now practically all the year round. It is principally done by Burmese girls.

The capital invested is from £22 to £25 per acre to bring to bearing. The average cost of production is about 1*s.* 6*d.* to 1*s.* $10\frac{1}{2}$*d.* per pound.

The exports of rubber from the Gold Coast Colony in 1912 were 1,990,699 lb. as against 2,668,667 lb. in 1914. The average annual yield of Para rubber (Hevea) at the several experimental stations was $3\frac{3}{4}$ lb. per tree. *Funtumia* has given over 56 per cent. of its total yield at the first tapping, in contrast with Para, where the quantity of latex tends to increase after the first tapping.

—MONTHLY BULLETIN.

DECOMPOSING OF RUBBER THROUGH MICROBES.

In dealing with the above subjects, N. L. SÖHNGEN and J. G. FOL lately considered the following questions:—

Are the mechanical properties of the portions coloured by the action of microbes from those of the uncoloured rubber? Is there consequently any reason for a lower valuation of coloured rubber? Is the hydro-carbon in rubber subject to the attacks of microbes?

In the second part of the article the authors speak of the micro-organisms in rubber and their influence upon its mechanical qualities. They first give a review of the subject and record their experiments regarding micro-organisms and the mechanical properties of spotted rubber. They deduce the opinion that the microbes forming the spots beyond the discolouration exercise no injurious effects on the rubber. Thus, a lower valuation of spotted rubber cannot be defended. According to their opinion it is, however, advisable to prevent the growth of the micro-organisms, which can be accomplished by a suitable arrangement of the drying chambers. It is only at a certain degree of moisture that microbes are developed in rubber.

The third part of their article treats in detail of the microbes which attack the rubber, the following results being obtained by the authors:

1. On air-dried rubber (containing 0·5 per cent. of water) micro-organisms cannot be developed in consequence of the lack of water.

2. When water is present in abundance, commercial rubber is a medium for the development of many kinds of bacteria and germs, to the detriment

of the albumens, sugars and resins which are present. Some kind produce red, black or brown spots without noticeably changing the mechanical properties of the rubber.

3. Two kinds of *actinomyces* often found in garden soil and sewer water, *actinomyces elastica* and *actinomyces fuscus*, are in a position to attack and assimilate the hydro-carbon in rubber.

4. From these microbes an enzyme attacking rubber and soluble in water is not obtained by separation.

5. The knowledge of the facts—first that the development of microbes can take place in moist rubber, when the rubber hydro-carbon is not decomposed, and the mechanical properties do not change, but where pigments are often given off, which diminish the market value of the rubber ; and secondly that there are kinds of *antinomyces* which can positively attack the hydro-carbon of rubber, and thus lower the viscosity,—makes it desirable to again urge that it is of the greatest practical interest to prevent as far as possible the development of micro-organisms in rubber. The growth of microbes is prevented by the rubber being dried on the plantation as quickly and carefully as possible in suitably arranged drying chambers.—INDIA RUBBER WORLD.

RUBBER MEN ON THE RIO ROOSEVELT.

THE GEOGRAPHICAL JOURNAL for February contains MR. ROOSEVELT'S paper on a Journey in Central Brazil which he read before the Royal Geographical Society on June 16th, 1914. MR. ROOSEVELT has the following references to the Rubber collectors whom he first met after six weeks' toilsome journeying on the river Castanho :—The point was that no one knew where this mouth was, or the course of the stream, or its length, or anything else about it. Where we actually did come out was on the stream known to the rubber men as the Aripuana. On this map there is no name given to the little bit of a dotted creek running into the Madeira which I suppose is meant for the Aripuana. On a few other maps, however, it appears, with its name as the Aripuana, as a very small creek indicated by a dotted line, entering into the Madeira. It is portrayed on these maps as smaller than several other insignificant tributaries, yet as a matter of fact, instead of being much smaller, it is very much larger. It is difficult to understand how it is possible that a great river, whose mouth and lower course are so well known to the rubber men, could have been left off the maps, or else put on as a tiny tributary with nothing to indicate its size or course. The rubber men had insisted that the Aripuana was the biggest river flowing into the Madeira, although it appears on the map as one of the smallest and most unimportant.

We found that the rubber men called the stream we were on the Castanho. Every day or two we came to a rubber man's house, and on several days we passed two or three. They were always most kind and courteous, and gave us out of their poverty anything they could afford. As we came down, it seemed extraordinary enough that the part of the river which no civilized man had ever traversed should be absolutely unguessed at

as far as any cartographer was concerned, but it was more extraordinary still when, lower down, we were on a stream practically of the volume of the Rhine which had been known for years to the rubber gatherers, and realized that on no map was there a hint of this great river's existence, except in so far as there appeared on some maps an inaccurate indication of the mouth. If any man only wishes to ascend the lower two-thirds of the Duvida, or Aripuana and Castanho, the work will be simple, rather easy, and free from danger. I will give letters to the big rubber men which will enable him to purchase the proper canoes and provisions, and hire proper guides.

In the same number of the Journal there is a review on a book entitled ECONOMIC GEOGRAPHY by J. M. MCFARLANE in which the following criticism will be found of interest :—So on p.470 the emphasis should be, not on the fact that Para rubber needs to be "flooded for a considerable part of the year," which everyone knows, but on the fact that the real black Para (the context being "the best quality") owes its special resiliency to its being flooded for an *inconsiderable* part of the year (mid-November to end of March), and for that reason comes only from westward of the head of tide, the chief centre for the best quality being Iquitos.

A number of experiments were made during the last year to test the specific gravity of latex, from which a suitable latex hydrometer has been constructed. This machine is made by J. J. GRIFFIN & SONS, London, and is intended for factory controls. Experiments were carried out to test the comparative value of formic and acetic acids for Hevea coagulation. It has been suggested that if the rubber prepared with formic acid proves equal to that produced with acetic acid the former should be substituted for the latter, being cheaper and more economical. It would be still cheaper but for the high freight charged on it by the steamship companies as being dangerous cargo.—INDIA RUBBER WORLD.

RAINFALL FOR FEBRUARY, 1915.

Place	1915	1914	Place	1915	1914
	in.	in.		in.	in.
Colombo	·20	1·56	Kurunegala	1·48	·07
Kandy	3·15	·52	Batticaloa	·70	6·31
Galle	2·09	·29	Badulla	4·43	1·03
Jaffna	1·25	0	Ratnapura	6·14	7·95
Anuradhapura	1·16	·27	Nuwara Eliya	2·11	·50

COCONUTS.

POONAC AND PALMNUT KERNEL CAKE.

Coconut cake and palmnut kernel cake are two feeding stuffs which are being brought prominently to the notice of stock owners as a result of the war. The main reason for this is that part of the large quantities of the raw products from which these cakes are manufactured, viz., "copra" and palmnut kernels respectively, which were formerly exported to Germany and Austria-Hungary, has now been diverted to the United Kingdom. A certain amount of coconut cake is manufactured in England, but hitherto practically all the palmnut kernels produced in Nigeria and other British Colonies have been exported to Germany.

Further, the closing of the German market has made it necessary for such parts of the Empire as depend largely on the export of copra and palmnut kernels to find new markets, and efforts are being made to establish new coconut and palmnut kernel-crushing industries in the United Kingdom. The success which might attend the establishment of such industries would partly depend (at any rate during the continuance of the war) on the extent to which the cakes could be disposed of to British farmers, who purchase very large quantities of feeding stuffs, and are always ready to utilise new oil cakes if they can be shown to be good value.

Experiments with one or other of these cakes are being undertaken at a number of Agricultural Colleges, but the results will probably not be available for some time. For this reason the results of such few English experiments as have already been conducted have had to be supplemented from German sources of information.

Copra and palmnut kernels are obtained by removing the shell from the coconut and palmnut respectively. The principal products obtained from the crushing of copra and palmnut kernels are coconut oil and palmnut oil respectively, these being used in the soap industry and in the manufacture of butter substitutes, chocolate fats, and various other edible fats.

The oil is obtained either by pressing the copra and palmnut kernels or by extraction with chemical solvents. In the former case the residues mostly take the form of cake; in the latter case, when the copra or palmnut kernels are ground the residues take the form of meal.

The composition of the cakes naturally varies with the efficiency of the crushing process employed to express the oil, and as the process improves the resulting cakes tend to show a lower percentage of oil and a correspondingly larger percentage of other nutrients than cakes produced by the older methods. When the oil is extracted by solvents, much less is left in the residue than would be left by the crushing process.

ANALYSES.

The following tables show, for coconut and palmnut kernel cakes, the average of a large number of analyses given by various experimenters

together with the minimum and maximum figures found for each individual constituent :—

COCONUT CAKE (CRUDE NUTRIENTS.)

(Average of 25 analyses, many of which are themselves averages.)

——	Moisture.	Oil.	Crude Protein.	Carbo-hydrates.	Crude Fibre.	Ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Minimum ...	4·17	7·20	17·87	25·92	7·04	4·10
Maximum ...	13·16	21·96	24·50	48·00	20·60	9·55
Average ...	11·05	11·18	20·80	39·09	12·51	5·95

PALMNUT KERNEL CAKE (CRUDE NUTRIENTS).

(Average of 11 analyses, some of which are themselves averages.)

——	Moisture.	Oil.	Crude Protein.	Carbo-hydrates.	Crude Fibre.	Ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Minimum ...	9·70	4·40	15·89	33·40	10·00	3·55
Maximum ...	13·40	12·91	19·12	50·00	24·98	4·00
Average ...	11·06	7·90	17·15	41·54	18·29	3·83

For purposes of comparison the composition of average samples of the commoner feeding cakes are given below :—

——	Moisture.	Oil.	Crude Protein.	Carbo-hydrates.	Crude Fibre.
	Per cent	Per cent.	Per cent.	Per cent.	Per cent.
Linseed Cake	12	10	30	34	9
Decorticated Cotton Cake	8	9	41	26	8
Undecorticated Cotton Cake	12	5½	22	34	20

The approximate prices per ton for the various cakes named in Liverpool in the middle of January were as follows :—Linseed cake, £11; decorticated cotton cake, £9. 5s.; undecorticated cotton cake, £6; coconut cake,

£7 18*s.* 9*d.*; palmnut kernel cake, £6 8*s.* 9*d.* On the basis of these figures, and of the average crude nutrients given above, the price for food unit* (crude, and disregarding fibre) would average about 1*s.* 7¾*d.* for linseed cake; 1*s.* 2¾*d.* for decorticated cotton cake; 1*s.* 2*d.* for undecorticated cotton cake; 1*s.* 4*d.* for coconut cake; and 1*s.* 2¾*d.* for palmnut kernel cake.

DIGESTIBILITY.

The following results of digestibility experiments are given by various German authorities (per cent.):—

DIGESTIBILITY COEFFICIENTS.

——	Organic Substances.	Oil.	Crude Protein.	Carbohydrates.	Crude Fibre.
			Coconut Cake.		
Ruminants:					
Kellner	80	97	78	83	63
Pott	—	100	81	84	—
Pigs:					
Kellner	80	83	73	89	60
			Palmnut Kernel Cake.		
Ruminants:					
Kellner	70	98	75	77	39
Pigs:					
Kellner	68	78	69	77	36
Sheep:					
Weiniger *(Kuchenmehl)*	77	79	77	89	39
			Linseed Cake, Decorticated Cotton Cake, and Undecorticated Cotton Cake.		
Ruminants:					
Kellner					
Linseed Cake ...	79	92	86	78	32
Decorticated Cotton Cake ...	76	94	86	67	28
Undecorticated Cotton Cake	55	93	77	52	18

As regards digestibility of total organic matter, coconut cake is equal to linseed cake and ranks above decorticated cotton cake, while palmnut kernel cake falls below decorticated cotton cake.

Applying Kellner's digestibility coefficients for ruminants to the average analyses given on p. 216, the proportion of digestible nutrients of coconut cake and palmnut kernel cake, with the corresponding figures for the

* The number of food units is obtained by multiplying the oil and albuminoids by 2½ and adding to the carbohydrates. This assumes that the differences in the manure values will be sufficiently allowed for in the high value assigned to the albuminoids.

commoner cakes, would be approximately as follows:—

——	Oil.	Crude Protein.	Carbo-hydrates.
	Per cent.	Per cent.	Per cent.
Coconut Cake	10·84	16·22	32·44
Palmnut Kernel Cake ..	7·74	12·86	31·99
Linseed Cake	9·20	25·80	26·52
Decorticated Cotton Cake ...	8·46	35·26	17·42
Undecorticated Cotton Cake ...	5·11	16·94	17·68

On the basis of their digestible nutrients the price per food unit would be about 1*s.* 7*d.* for coconut cake, and 1*s.* 6½*d.* for palmnut kernel cake, compared with about 1*s.* 5½*d.* for decorticated cotton cake, 1*s.* 8*d.* for undecorticated cotton cake, and 1*s.* 11*d.* for linseed cake.

In considering the digestibility of a food, the amount of fibre and its condition must be taken into account. The amount of crude fibre in both coconut and palmnut kernel cakes (especially the latter) seems to be well above that found in linseed and decorticated coconut cakes; but the fibre of coconut and palmnut kernel cakes (especially the former) appears to be much more digestible than that of the two latter cakes, In the most recently made samples of palmnut kernel cake the proportion of fibre is not very much more than that found in linseed cake.

POONAC AND KERNEL CAKE AS FOODS FOR STOCK.

Palmnut kernel cakes in the past have had the reputation of soon going rancid, and this is generally ascribed to an excess of oil present, At the present day, before the kernels are crushed they are subjected to a process of cooking by which the ferment that causes the oil to turn rancid is rendered inactive; if palmnut kernel cake is stored in a suitable, dry place, there is little danger of fermentation taking place.

When cakes contain a very low percentage of oil the great pressure which has been employed makes the cake excessively hard and renders full utilisation by stock difficult. Specific effects are ascribed to the oil (see later) so that from this point of view also the percentage of oil should not be too low. In any case it is not advisable for users of palmnut kernel cake to lay in large stocks; and the cake should be kept unbroken until actually needed for feeding stock.

These considerations as to the oil content of palmnut kernel cake probably apply also in great measure to coconut cake.

Good samples of coconut cake are bright red or brown to brownish-grey in colour, while those of palmnut kernel cake are of a whitish-grey colour. Adulteration is not common.

When gradually accustomed to the foods both kinds of cake seem to be readily eaten by all classes of stock. They are mostly fed dry. When prepared with warm water palmnut kernel cake has an unpleasant taste; if

it is moistened at all it should not be allowed to stand long. Manufacturers sometimes recommend steeping coconut cake in water, but this is hardly necessary when the animals are receiving quantities of roots.

DAIRY COWS.

Both coconut cake and palmnut kernel cake have been used in Germany, principally for dairy cows, and are said to have a favourable effect on the quantity and quality of the milk fat. This characteristic appears to depend on the special nature of the fats in the two cakes.

Up to 5 lb. per head per day may be fed in the case of palmnut kernel cake and up to 4 lb. in the case of coconut cake. Larger quantities of the cakes than these have, however, been fed to dairy cows without any ill effects. The larger quantities are liable to induce excessive hardness in the butter, while serving to correct the effect of foods which give rise to softness in butter. Small amounts would probably prove useful in warm weather, when difficulty is experienced in making firm butter. It is important that the cakes should not be rancid, since, if this is the case, the milk and butter produced are likely to have a bad flavour.

According to Pott the limits of the favourable effect on butter production appear to be reached in the case of palmnut kernel cake when $2\frac{1}{4}$ lb. are fed per head per day, but Kellner (1911 report) doubts whether smaller quantities than 5 lb. per head per day of palmnut kernel cake would have any effect on the fat content of the milk.

Recent English experiments on the feeding of coconut cake to dairy cows have been conducted at the South Eastern Agricultural College, Wye, and at the Midland Agricultural and Dairy College. In the Wye College experiment, the quantity of coconut cake fed reached 6 lb. per head per day. In the Midland College experiment the addition of 5 lb. per head per day of coconut cake to the basal ration of Shorthorn cows was compared with $4\frac{1}{2}$ lb. of linseed cake. The total milk yields during the fortnight were 2,472 lb. from linseed cake, and 2,429 lb. from coconut cake. The live weight increase, however, was greater in the case of coconut cake, while the butter obtained from this food was firmer and better flavoured than that from linseed cake. The results were financially in favour of coconut cake, "this cake at £6 15*s.* per ton appearing to be well worth consideration when linseed cake is more than £9 per ton."

In a comparison between butter from coconut cake feeding and linseed cake feeding, it was observed that the former butter had better keeping properties than the latter. No very great differences were shown in the flavour and texture of the two lots of butter. The coconut cake butter had, as a rule, a firmer and less oily texture and a better flavour.

Palmnut kernel cake was recently compared with decorticated cotton cake in an experiment at the Lancashire County Council Farm at Hutton.

It was concluded that palmnut kernel cake could be recommended as a safe food for milch cows, although it was not more profitable to feed it at £5 2*s.* 6*d.* per ton than decorticated cotton cake at £8 12*s.* per ton. No difficulty was experienced in getting the cows to eat $7\frac{1}{2}$ lb. per head per day of palmnut kernel cake when this amount was gradually worked up to, but this amount was large, and better results might have been obtained had the food been fed as only part of the cake ration. Even the large quantity of palmnut kernel cake fed had no undesirable effect on the butter produced.

FATTENING CATTLE.

At the prices which prevailed in Germany before the outbreak of war, both coconut and palmnut kernel cake would seem to have been found less suitable for fattening cattle than were several other concentrated foods.

An experiment carried out by the Edinburgh and East of Scotland College of Agriculture (Report XXVII.), in which the addition of 4 lb. of coconut cake per head per day to the basal ration was compared with 4 lb. of linseed cake, showed the average daily increase from coconut cake to be 1·91 lb. per head compared with 2·25 lb. from the linseed cake. Taking into account the respective manurial values,* the conclusion was reached that when the price of good average linseed cake is £9 per ton, the value of coconut cake for fattening purposes is £6 1*s.* 8*d.* per ton.

CONCLUSIONS.

1. Palmnut kernel and coconut cakes or meals are valuable foodstuffs, particularly for milch cows, when they can be obtained of good quality at a price which compares favourably with the prices of such feeding stuffs as linseed cake and cotton cake. They are also useful for replacing oats for horses, but are probably of less value for fattening bullocks, sheep and pigs.

2. Farmers should buy under guarantee as to analysis, paying special attention to the percentage of oil, fibre, albuminoids and carbohydrates. They should insist on fresh, well-made cake, and should not buy more than a three months' supply.—JOURNAL OF THE BOARD OF AGRICULTURE.

TWO INSECT PESTS OF COCONUTS.

The principal pests of coconuts are the black or rhinoceros beetle *(Oryctes rhinoceros)*, and the red beetle, or Asiatic palm weevil *(Rhynchophorus ferrugineus)*.

Oryctes rhinoceros is a shiny, dark-brown or practically black beetle, ranging in length from 30 to 60 mm., with the usual size between 40 and 50 mm. The male is the larger, and is also distinguished by the prominent horn on the dorsal surface of the head, which in this sex is sometimes as much as one centimetre (2/5 inch) in length, while in the female it is smaller, often inconspicuous. The life-cycle probably varies in length, certain writers on the subject (COPELAND amongst these) believing that in some cases it may not occupy more than seven months, while others hold the opinion that the larval life alone may extend over a period of two years.

The eggs are not described. The larvæ reach a length of 1 decimetre (about 4 inches) when they enjoy particularly favourable conditions. The larvæ live in decaying vegetable matter of all kinds, and the cocoons are formed in the same situations.

The injury to coconut trees is caused by the adult beetles, which eat their way into the bud, starting at the bases of the leaves.

The means of controlling this insect are the destruction of the beetles in the tree by their removal by the use of a wire probe ; the destruction of their breeding places by the removal of all accumulations of rubbish ; and by

* The manurial values of HALL and VOELCKER for the different cakes are as follows, per ton :—Coconut cake, 34*s.* 7*d.* ; palmnut kernel cake 22*s.* 11*d.* ; decorticated cotton cake, 64*s.* 9*d.* ; undecorticated cotton cake, 37*s.* 1*d.* ; linseed cake, 44*s.* 4*d.*

means of traps, which consist of holes filled with specially prepared vegetable refuse and mould, which furnish satisfactory breeding places, these being regularly examined, and the beetles, cocoons, larvae, and eggs collected and destroyed.

The last method is believed to be the most effective means of controlling the black beetle. References to this beetle have been made in the Agricultural News, Vol. XI., pp. 218 and 378, and Vol. XIII, p. 10. The last of these gives an account of the successful use of a parasitic fungus in the beetle traps which kills many of the larvæ.

The red beetle, or Asiatic palm wevil *(Rhynchophorus ferrugincus)* is related to the West Indian palm weevil *(R. palmarum)*, and attacks coconut trees in the same way. The red beetle is said to be the most deadly insect pest of coconuts in the Philippines, but since it cannot attack sound trees, it is not the hardest to combat.

Its length ranges from about 3 to more than 5 centimetres (11/5 to 2 inches). Its colour varies from reddish to almost black. It attacks the coconut and other palms, but is not known to infest plants of other groups.

The length of the life-cycle is variously estimated to cover a period of from ten weeks to about one year.

The red beetle is not able to penetrate into the tissues of a healthy coconut tree, but takes advantage of injuries of all sorts, which results from any breaking of the surface. The holes of the rhinoceros beetle, wounds resulting from hurricanes, fires, careless or unnecessary pruning, all offer means of access to the egg-laying female.

It has been found that the removal of old leaves, and the firing of the tops in an attempt to check other insects or disease result in attack by this pest.

The methods of combating this insect include, (1) all precautions against injuring the coconut tree, in which, of course, the control of the rhinoceros beetle plays an important part ; (2) the removal and destruction of all infested coconut or other palm trees ; (3) extracting the beetles and the larvæ from their burrows and places of concealment in the tree ; (4) the use of bait and traps, which consists in the felling and leaving exposed on the ground, under suitable conditions, of any dead coconut or other palm known to be attractive to the insect, until eggs have been laid in them and the larvæ have hatched, when the trap material is destroyed, preferably by fire. Mangoes crushed in coconut milk and water, and exposed in shallow dishes are also said to have been recommended as a trap. The use of poisons, such as carbon bisulphide, cyanide of potassium, and hydrocyanic acid has been tried for the control of this insect, but without practical results.

A number of other beetles, including some weevils, are also mentioned as being pests in the East, and reference is made to those which occur in the American tropics.

The most serious leaf-eating beetles mentioned are small beetles of the family Hispidæ, which both as larvæ and adults feed upon the leaves, and are the cause of serious injury to the trees.

One of these, *Bronthispa froggatti*, is stated to be considered by Froggatt as certainly the worst pest the planters in the Solomon Islands have to fight

in their young coconut plantations. The result of the attack is that the leaves are reduced to skeletons connected by dead membranes before they are well unfolded. In Eastern Java the same, or a nearly related species, attacks the coconut leaves in a similar way. In the Solomon Islands gangs of boys are kept at work shaking soap and kerosene wash into the still folded leaves.

In the related genus, Promocotheca, three species are known as coconut pests: *P. cumingii* in the Philippines, *P. antiqua* in New Guinea, and *P. opicicollia* in the New Hebrides.

The Philippine species is a small beetle from 7·5 to 10 mm. in length. It is sluggish in habit, and does not fly readily on being disturbed.

The adult beetles crawl between the folded-up leaflets of the young leaf, and eat small spots between the veins of the leaf.

The damage done by the larva is greater than that done by the adult. The eggs are inserted by the adult female just beneath the epidermis of the leaf. The larvæ, on hatching, penetrate into the tissue where they feed, and pupate later. The spots eaten by the beetles, and those excavated by the larvæ, become dry and discoloured when the leaf opens out, and give to a badly attacked tree a very unsightly appearance. In addition, the effect of a serious attack is very injurious to the tree.

This insect is controlled to a large extent by two hymenopterous parasites.

A number of moth and butterfly larvæ also feed upon the coconut leaves, but these are pests of a rather local nature. Two of these, *Brachartona catoxantha* and *Hidara irawa*, occur in other parts of the East; while two others, *Padraona chrysozona*, and *Thosea cinereomarginata* occur in the Philippines.

Brassolis isthmia, which occurs in Panama, and *B. sophoræ* in British Guiana, are two other leaf eating insects included in the list.

Omiodes blackburni, which is known as the palm leaf roller in Hawaii, is also mentioned.

Locusts are recorded as occasional serious pests in Madagascar, and the author states that in Mindanao he has seen coconuts thoroughly stripped by these insects, and so badly injured that the fruiting would be delayed two years.

Another Orthopteron, *Græffea cocophaga*, one of the walking sticks, or stick insects, has at times been a pest in certain places.

Its distribution extends from New South Wales northward and eastward across Polynesia. It feeds on coconuts and has temporarily done considerable damage in places. It is large in size—about 20 centimetres (8½ inches) in length—but is inconspicuous on account of its colour.

Of all the scale insects, some thirty species, recorded as attacking coconut, *Aspidiotus destructor*, is stated to be the only one which is ever found in large numbers and charged with doing serious damage. *A. destructor* is probably found in every land where the coconut is grown. It is said to have been most serious in the Caroline Islands, where the coconut is the staple crop, but its occurrence is universal in coconut growing districts,

and while often kept in check by its natural enemies, it may at any time become sufficiently abundant to be a serious pest. The lady-birds of the genus Chilocorus appear to be the most efficient of its natural enemies. Trees that are growing under suitable conditions are less likely to be seriously attacked by this pest. To guard against injury by it trees should be amply spaced, provided with plenty of water in the ground, and, if necessary, cultivated and manured. It is stated that in Trinidad *Aspidiotus destructor* is often protected by an ant *(Aztecta charifex)* in such a way that the scale is completely guarded against its natural enemies.

The miscellaneous pests of coconuts include such forms as the robber crab *(Birgus latro)*, parrots and crows, bats, rats, bandicoots, porcupines, hogs, and bears. The hog is said to be the worst pest of all these, destroying seed nuts which have been planted out, and young trees. In the Malay States, bears, pigs, and rats are said to do more damage to coconuts than the beetles. In Lower Perak, bears recently destroyed more than 1,000 coconut trees in one year.—Agricultural News.

COCONUT INDUSTRY OF THE EMPIRE.

Large quantities of coconut oil are produced by natives in India, Ceylon and elsewhere, whilst the dried kernels of the coconut, known as copra, are largely exported to Europe, and the oil extracted by modern milling methods Prior to the war the chief countries importing copra were Germany and France, but owing to the complete cessation of trade from British possessions to the former country, as well as to Austria-Hungary, large quantities of copra from Ceylon, India, the Federated Malay States, and other countries have become available for use elsewhere, and in the present article attention is called to the magnitude of this trade and to the desirability of British merchants and manufacturers securing a larger proportion of copra for industrial purposes in this country.

The quantities and values of the exports of copra from some of the more important producing countries are shown in the following table ; the figures in each case are for the last year for which statistics are available :—

British Territories :	Year.	Quantity. Cwt.	Value. £
Ceylon ...	1913	1,117,292	1,397,284
India ...	1913-14	763,832	1,039,826
Federated Malay States ...	1913	185,753	211,043
Seychelles ...	1913	58,738	71,919
Tongan Islands Protectorate	1912	222,400	209,567
Fiji Islands ...	1913	158,585	176,741
Papua ...	1912-13	15,880	16,356
British Solomon Islands ...	1912-13	83,920	73,637
Gilbert and Ellice Islands Protectorate ...	1911	41,700	20,700
East Africa Protectorate ...	1912-13	31,283	31,956
Zanzibar ...	1913	—	216,842
Gold Coast ...	1913	12,589	14,291
Trinidad ...	1913	10,308	11,545

Foreign Territories.	Year.	Quantity. Cwt.	Value. £
Philippine Islands ..	1913	1,618,080	1,988,692
Java ...	1913	1,556,000	—
Sumatra (East Coast) ...	1912	80,860	—
Celebes ...	1913	580,340	—
Indo-China ...	1912	157,074	95,783
New Caledonia ...	1912	53,173	64,850
French Oceania ...	1912	117,662	112,569
Samoa ...	1912	220,423	203,496
Bismarck Archipelago, German Solomon Islands and German New Guinea ...	1912	223,814	202,603
East Carolines, Marshall Islands and Nauru ...	1912	94,940	82,820
West Carolines, Pelew and Mariana Islands ...	1912	21,706	15,091
German East Africa ...	1912	83,468	78,152
Portuguese East Africa ...	1911	78,820	48,066

The following tables, giving the distribution of the exports of copra from British possessions, show that in many cases a very large proportion of the trade was with Germany; in the case of Ceylon no less than three-quarters of the exports went to Germany in 1913, and in the case of India in 1912-13 as much as four-fifths.

CEYLON.

	1911.		1912.		1913	
	cwt.	£.	cwt.	£.	cwt.	£.
United Kingdom ...	10,503	9,382	9,996	10,804	1,500	2,001
India ...	56	27	—	—	163	244
Austria-Hungary ...	12,096	13,120	29,977	31,956	30,041	37,518
Belgium ...	14,508	14,439	4,020	2,445	18,000	23,422
Denmark ...	11,500	14,133	68,000	79,285	25,667	34,639
France ...	7,999	7,934	2,000	2,200	1,003	1,000
Germany ...	567,473	612,312	368,034	408,525	814,979	1,013,486
Holland ...	1,000	1,000	1,000	1,067	1,059	1,200
Roumania ...	—	—	—	—	4,000	5,600
Russia ...	191,171	200,341	131,042	135,893	220,880	278,174
United States ...	5,508	5,500	—	—	—	—
Total...	821,814	878,188	614,089	672,175	1,117,292	1,397,284

INDIA.

	1910—11.		1911—12.		1912—13.	
	cwt.	£.	cwt.	£.	cwt.	£
United Kingdom ...	5,929	7,013	40,814	51,865	43,999	54,318
British Possessions	1,771	1,490	847	834	753	852
Russia ...	24,856	29,323	31,485	36,373	43,184	54,886
Germany ...	348,556	409,359	473,292	563,168	548,331	687,142
Holland ...	1,997	2,663	12,735	15,866	8,492	10,258
Belgium ...	11,360	13,250	25,485	29,718	13,904	15,889
France ...	54,401	61,994	48,490	56,920	26,049	32,367
Other countries ...	757	1,043	4,375	4,914	2,281	3,153
Total...	449,627	526,135	637,523	759,658	686,993	858,865

FEDERATED MALAY STATES.

Most of the copra exported from the Federated Malay States is sent to the Straits Settlements, but no information is available as to its ultimate destination. The total exports in recent years are as follows :

	cwt.	£.
1910 ...	149,726	139,326
1911	160,790	151,002
1912 ...	154,204	152,036
1913 ...	185,753	211,043

PROTECTED MALAY STATES.

A considerable amount of copra is produced in the States of Perlis, Kelantan, Trengganu, and Johore. No statistics of the exports from the last-named State are available, but in 1912. 161,648 cwt., valued at £157,548 were imported into Singapore from Johore. The exports from the other States mentioned in the last year for which statistics are available were as follows :

	Year.	cwt.	£
Perlis ...	1911	5,146	—
Kelantan ...	1912	90,995	89,176
Trengganu ...	1912	27,715	28,044

There is a very considerable transit trade in copra in the Straits Settlements, and large quantities are exported to Europe from Singapore and Penang. That shipped from the former port is derived mainly from the Netherland East Indies, Malay Peninsula, Philippine Islands, and Siam, whilst that shipped from Penang comes chiefly from the Netherland East

Indies and the Malay Peninsula. The total exports from Singapore and Penang in 1912 were as follows :

	Singapore.		Penang.	
	Cwt.	£	Cwt.	£
United Kingdom -	41,774	45,205	11,431	14,308
Austria-Hungary -	62,127	64,550	4,981	5,577
Belgium -	28,600	30,081	1,001	1,027
Denmark -	94,742	102,823	75,330	81,863
France -	172,531	179,820	21,414	23,317
Germany -	402,643	420,934	258,026	290,332
Russia -	304,969	317,868	55,571	60,170
Other countries -	72,257	74,965	3,010	2,648
Total -	1,179,643	1,236,246	430,764	479,242

The Trade Returns for the United Kingdom show that in 1913 this country also imported about 18,600 metric tons of coconut oil from foreign countries other than Germany. The total imports of foreign coconut oil to the United Kingdom in 1913, therefore, amounted to about 49,000 metric tons, corresponding to about 82,000 tons of copra.

It is, moreover, certain that from all these foreign countries which export coconut oil to the United Kingdom, and especially from Germany, considerable quantities of coconut oil also reach this country in the form of margarine, vegetable butter, and prepared fats and foods of various kinds. No definite figures can be suggested for the amount received in this way

It is clear from the foregoing data that considerably more than half of the British copra hitherto exported to Germany and Austria-Hungary might be taken by the United Kingdom for home use, either in the form of copra or coconut oil. Ceylon and India both produce copra and coconut oil, so that these countries could probably divert their supplies in either form to the United Kingdom. It is understood moreover that firms crushing copra in the United Kingdom are now extending their plant, so that there is a good prospect of the British market for copra being greatly enlarged.

In addition to the possibility of finding a market in the United Kingdom, there appears to be a considerable chance of the British Colonies and India securing a share of the French import trade in copra. In 1912 the total imports of copra into France were 153,506 metric tons. Of this 19,691 metric tons came from British Possessions, and 10,321 metric tons from French Colonies. Of the remainder 43,422 metric tons came from the Netherland East Indies and 72,964 metric tons from the Philippines. It ought to be possible for Ceylon, India, and the Federated Malay States to

compete on favourable terms with the Netherland East Indies and the Philippines for this trade.

Apart from the United Kingdom and France the new markets available for British copra are small. In the case of the United States the imports of copra in 1913 amounted to 15,548 metric tons, of which 10,674 metric tons came from the Philippines, and the rest mainly from French, British, and German Possessions in the Pacific. The imports of coconut oil to the United States amounted in 1913 to 22,915 metric tons, of which about 18,000 metric tons came from Ceylon, India, the United Kingdom, and Australia, and the rest chiefly from France, Germany, and the Philippines.

In Holland it may be difficult to replace the imports from the Netherland East Indies by British copra and coconut oil, but there seems to be some possibility for the development of export to Denmark, Scandinavia, and Russia.

USES AND VALUE OF COPRA.

The copra imported to Europe and elsewhere is used as a source of oil (coconut oil) and feeding cake (copra or coconut cake). The methods of preparing copra have been dealt with already in this Bulletin in an article on the coconut and its commercial uses (1912, 10,274), and it is proposed to deal now merely with its utilisation and value. The copra exported from the different countries varies somewhat in quality; the values of the more important grades in London, Marseilles and Hamburg are shown below :—

	London. (Jan. 21st, 1915), per ton.	Marseilles. (July 17th, 1914), per 100 kilos.
	£ s. d.	frs.
Malabar ...	26 2 6	—
Ceylon ...	25 10 0	63
Malay and Straits ...	£24 0 0—£24 10s. 0d.	59·50
Zanzibar ...	—	59·50
Manila ...	23 12 6	58·50
Samoa ...	24 17 6	59·50
East Africa ...	24 5 0	—

COCONUT OIL.

As already mentioned, large quantities of coconut oil are prepared from

the fresh kernels in Ceylon and India, the exports in recent years being as follows :—

EXPORTS OF COCONUT OIL FROM CEYLON.

	1911.		1912.		1913.	
	cwt.	£	cwt.	£	cwt.	£
United Kingdom ...	258,664	448,868	167,586	294,393	150,650	307,326
British Possessions	2,120	3,679	1,789	3,143	2,261	4,612
Austria Hungary ...	16,253	28,204	17,975	31,576	14,300	29,172
Belgium ...	10,247	17,782	2,804	4,826	4,407	8,990
France ...	119	206	—	—	5	10
Germany ...	16,960	29,431	5,305	9,321	1,712	3,493
Holland ...	2,038	3,537	1,441	2,531	3,116	6,357
India (other than British) ...	952	1,652	1,092	1,918	1,203	2,454
Italy ...	852	1,478	2,046	3,594	2,311	4,715
Mozambique ...	3,001	5,208	441	775	276	563
Norway ...	12,072	20,949	31,423	55,200	40,626	82,777
Russia ...	—	—	—	—	401	818
Sweden ...	3,998	6,938	3,779	6,638	3,411	6,958
United States ..	177,731	308,422	166,053	291,700	322,305	657,502
Other foreign countries ...	9	16	44	77	—	—
Total ...	505,016	876,370	401,779	705,792	546,984	1,115,847

EXPORTS OF COCONUT OIL FROM INDIA.

	1910-11		1911-12		1912-13	
	Gals.	£	Gals.	£	Gals.	£
United Kingdom.	317,670	39,363	557,292	72,076	217,655	29,499
British Possessions	41,295	5,742	59,117	8,133	48,174	6,811
Sweden ...	191,171	21,763	316,295	40,998	99,385	13,217
Germany ...	711,434	84,208	584,251	65,469	163,940	20,929
Holland ...	30,887	3,590	60,306	7,772	39,337	5,017
Belgium ...	103,326	12,503	34,506	4,507	46,229	6,189
United States ...	485,567	58,575	477,487	62,080	327,899	43,644
Other foreign countries ...	53,258	6,899	75,849	9,777	26,875	3,715
Total...	1,934,608	223,643	2,165,103	270,812	969,494	129,021

Nearly all the Indian oil is prepared in Madras, and particularly on the Malabar coast. The Cochin oil produced in the latter region is on the whole more carefully prepared than Ceylon oil, and consequently realises higher prices. The values of Cochin and Ceylon oils in London at the present time are £55 and £48 10*s.* per ton, respectively (February, 1915).

The quality of the oil prepared by expression from copra in Europe, the United States, and elsewhere depends largely on the quality of the copra used. Sun-dried copra yields an oil of paler colour than kiln-dried copra,

whilst that obtained from imperfectly dried copra is of higher acidity and inferior quality. The current value of London-expressed oil is £40 5*s.* per ton (February, 1915). The oil content depends on the thoroughness with which the copra has been dried. Thus, sun-dried kernels contain about 50 per cent. of oil; kiln-dried kernels contain 63 to 65 per cent. and hot-air-dried copra up to as much as 74 per cent. The ground copra is expressed twice at a temperature of 55° to 60° C., the yield of oil from average copra being about 62 to 63 per cent.

At the average European temperature coconut oil is a solid fat, varying in colour from white to yellowish according to the quality of the copra and the method of preparation. The unrefined oil prepared from the best quality copra possesses the characteristic smell and taste of the fresh coconut, but that obtained from the lower grades of copra is often rancid and disagreeable in smell and taste. By suitable refining methods, however, an odourless and tasteless oil may be produced, and the refining of coconut oil for the production of edible fats is now an important industry. The following table gives the range of the principal constants of coconut oil.

Specific gravity at $\frac{99° \text{ C.}}{15° \text{ C.}}$		0·874	
Iodine value	per cent.	8·0	—10·0
Saponification value		246	—26·8
Hehner value		82·4	—90·5
Reichert-Meissal value		6·6	— 7·5
Polenske value			18·0
Titer test		21·2° C.	—25 2° C.

Refined coconut oil is used in the preparation of solid edible fats such as margarine, vegetable butters, cooking fats, and chocolate fats, as well as in the manufacture of cakes, biscuits, sweetmeats, etc. In order to obtain a fat of firmer consistence and higher melting point, a certain proportion of the liquid constituents of the oil ("coconut olein") is removed by expression. The "coconut stearin" which is left is used for the purposes indicated above, when obtained from high-grade oil, while that obtained from the lower grades is used for candle manufacture. The extent of the trade in coconut oil and the edible products obtained from it has already been referred to—

Imperial Institute Bulletin.

RAINFALL FOR MARCH 1915.

Place	1915	1914	Place.	1915	1914.
	in.	in.		in.	in.
Colombo	10·29	3·84	Kurunegala	2·08	7·00
Kandy	4·07	6·62	Batticaloa	5·28	3·16
Galle	4·45	2·02	Badulla	4·79	4·14
Jaffna	·83	·22	Ratnapura	9·51	6·80
Anuradhapura	·04	3·31	Nuwara Eliya	4·85	3·01

CACAO.

POD ROT AND CANKER IN CACAO.

S. F. ASHBY.

Pods in all stages of development are attacked. A brown rot starts as a rule from the stem or flower end and rapidly advances up and down the pod. On the surface the brown area is sharply separated from the normal part, but internally in the wall of the pod the separation is not clear. Later the pod shrivels, turns black and hardens. In the brown stage a grey down may be seen just behind the advancing edge of the rot due to the colourless spores of the fungus borne on long delicate branches. As the pods shrivel and blacken, snow white mould and pink spots develop, due to other fungi living in the tissues killed by the real parasite, a Phytophthora. This fungus can gain entrance through the uninjured skin of the pod. If the pod attacked is immature enough for the beans to be still in contact with the wall the fungus enters and kills them; if the beans have drawn away from the wall they avoid attack and may be suitable for curing. The rot which advances from the flower end often enters the stalk and then the barl of the limb where it extends up and down colouring the bark wine purple and causing the so-called canker. A large amount of canker starts from the cushions in this way, being due to the rot passing through the pod stalks into the bark. The fungus is spread mainly from diseased pods, on which the spores form in great numbers, by means of wind, rain and insects. In infested plantations the trees will have diseased pods in one spot or another hanging throughout the year, each being a centre for the spread of disease. The disease is worst in wet seasons and in damp localities, especially where there is poor ventilation and much shading. The fungus forms thick resting spores on and in the pods; then gets washed into the soil or mixed with it in rotting husks and becomes an additional source of infection. The pod rot and canker can be completely controlled by systematic spraying with Bordeaux mixture, which should be regarded as one of the regular, necessary operations in good management. Collecting and burning diseased pods except in small cultivations does not pay for itself. Trees generally set more pods than they can mature, so that some on each cushion shrivel and fall at a very early stage. A serious number of these surviving young pods which the trees could mature are attacked by the rot and lost, so that the crop is always short from that cause. Spraying soon after the maximum amount of fruit has set saves these young pods and secures a full crop. The grown maturing pods are equally preserved so that the proportion of black cocoa picked is greatly reduced, and still further gain. It would probably pay to spray four times a year when the largest number of young pods are present. With an Alpha and large Holder Knapsack outfit one man can spray 100 trees a day and give a gallon to each. The cost of spraying 1,000 trees in labour and chemicals would not exceed £2 as a maximum and could, no doubt, be done for 30/-. Two sprayings in September, in Trinidad, at an interval of two weeks on blocks of 500 trees, compared with

a like number unsprayed, yielded on two estates a net profit of £9 and £4 per 1,000 trees during the following year. As most canker patches start from the pod, spraying greatly diminishes it by preventing fresh infection. Where already present, excision must be practised in addition. The best way to locate canker is by the black nature of the three-fourth grown pods at picking time. If canker has reached the cushion the places should be marked by paint or lime, so that excision may be performed as soon as work is slack. The reddish or purple bark should be entirely cut away without injuring the wood (as the fungus is confined to the bark), the edges trimmed smooth, and the wound covered by hot coal tar. Mr. J. B. Rorer, has made a thorough investigation of this disease in Trinidad and has proved conclusively that both pod rot and canker are due to the fungus—Phytophthora faberi (Maubl). I have examined the fungus from the rotting pods in Jamaica and find it to agree, both on the tissues and in pure culture, with the species described by him. The tissues rotted by this fungus are very quickly invaded by a number of other fungi, of which Colletotrichum Cradwickii (Bancroft) is most conspicuous here; these successors of the Phytophthora have misled several investigators of canker, who falsely concluded that one or another of them was the primary cause of the disease. I have recently examined two cases of diseased cocoa branches showing both the conidial and perfect fruits of the fungus, Sphaerostilbe musarum, which causes the Bonnygate disease of bananas. The branches bore the purple canker patches due to the Phytophthora and both these places and the normally coloured bark tissues, well beyond them, was penetrated by the black bordered rhizomorphs of the Sphaerostilbe. Both samples were from cocoa growing among bananas attacked by the disease, so that spores from the latter were carried to the cocoa pods, probably starting attack on the canker spots but also spreading in the bark beyond them. This finding supports the suggestion made in the description of Bonnygate disease that the fungus came originally from a woody plant. The following paragraphs are from Rorer's paper (Bull. Dept. Agr., Trinidad, No. 65, July 1910). When the tissues of the pod at the stem end have become well invaded by the fungus the mycelium runs back into the cushion either through the bark or the central woody cylinder of the stem of the pod. If it has gained entrance to the tree through the thin bark layer of the pod stem it generally spreads out in all directions, so that the whole cushion and surrounding area of the bark becomes cankered. The mycelium will extend in narrow lines from some distance up and down the stem in the cambium layer, but sooner or later will grow outward into the bark and then spread out rapidly, forming larger cankered areas. As the tissues of both pod and bark are killed by the advancing margin of growth of the Phytophthora mycelium they are quickly invaded by a number of rapidly growing fungi, as mentioned above, which produce spores very quickly on the diseased tissue. There can be no question that these fungi aid in the rapid disintegration of the already diseased pod tissues of cankered bark, but that they are not parasitic and cannot even attack tissues which have been wounded mechanically, has been proved by a larger number of inoculation experiments. A large number of inoculation experiments, made by the writer with pure cultures of Phytophthora, proves conclusively that this fungus is the cause of the common cacao pod rot and of the disease known as canker, and that the diseased pods serve as the chief source of infection of the tree.

PREVENTIVE MEASURES.

To control the pod disease two methods have generally been recommended. One is to gather and destroy all pods as soon as disease is noticed on them, and to husk black cocoa apart from the sound, and to burn, bury or lime all the husks ; the other is to prevent disease by spraying. Methods similar to the first have been frequently recommended for the control of a large number of fruit diseases, but from the fact that it is impossible to gather and destroy all the fruits, of whatever kind, as soon as they become diseased and that the fungi causing disease of this type produce spores within a very short period from the time of the first infection, the method is of a theoretic rather than a practical value. It has long since been given up as a means of controlling such diseases as brown rot of the peach, bitter rot of apple, black rot of the grape, and other fruit diseases. Moreover, a number of Trinidad planters who have tried this method as a means of controlling the cacao pod rot have told the writer that though the disease was reduced to a certain extent the cost of the labour used in collecting and destroying the blackened pods was in no way compensated for by the increased return from the general pickings, so that they gave up the method after a short trial. When the fact is considered that in the rainy season a pod may become infected and completely rotted within a week or ten days and that within three or four days from the time of infection hundreds of thousands of spores are produced, each one of which in germinating liberates from 10 to 30 smaller spores, each capable of reproducing the disease, it can be readily understood how futile it is to attempt to check the disease by gathering and destroying the diseased pods. The method of control by spraying, which has proved so successful in combating similar diseases in temperate climates, is undoubtedly the best to use against pod rot. Although a sufficiently large number of experiments have been carried out, either in Trinidad or elsewhere, to make it possible to give the best recommendations as regards time of spraying, mixtures to use, etc., yet the work which has already been done shows conclusively that the disease can be controlled by spraying, at a reasonable cost, that is at a cost which is more than compensated for by the increased yield. Up to the present time the writer has definite results from two sets of experiments. During the past eight months 2,125 more sound pods have been picked from 500 sprayed trees, than from 500 adjacent unsprayed trees, and the sprayed trees have yielded in total 1,608 more pods. Twenty-five per cent. of the cacao from the unsprayed trees has been black, while only 9 per cent, of that from the sprayed trees has been so. At some future time, perhaps, when estates are perfectly drained and cacao is grown without shade much less disease will be met with, but until that time comes both canker and pod rot must be controlled by spraying.

DIEBACK.

In this disease, the younger twigs begin to die and shed their leaves, and grey brown rot advances in the bark and outer wood down into the branches and the trunk, finally killing the tree. This rot, which is dry and fibrous in the older parts causing the bark to separate easily from the wood, is due to a fungus.—Lasiodiplodia, which is common on dead wood and pod shells in cocoa walks. The fruiting berries burst through the bark as black pustules and discharge great numbers of large oval spores at first colourless, later brown, with a dark line across the middle : when the disease reaches a

cushion bearing pod the fungus grows through the stalks into the walls and cavities of the pods, forming a white growth over the beans and a brown rot of the pod advancing to the flower end. The pods later become hard, shrivelled and black and bear the fruiting pustules of the fungus. The treatment consists in prompt pruning away of the diseased twigs and limbs and burning them. The pruning must be done well in advance of the discoloured bark, or fungus may be left to continue the rot. The larger cut surfaces should be treated with coal tar. The trees appear 'stag headed' in this disease, a condition which can also be acused by poverty of soil, wind, drought or root disease. In these cases if twigs are cut lengthwise, the dead brown bark is found to cease sharply against the living; in die-back disease the transition from dead to living is gradual. Trees in well-drained, weeded and mulched soils resist this disease, which is a sign of neglect.

ROOT DISEASE.

This is caused by the same fungus rotting the roots, especially in ill-drained or heavy soils. The leaves become sickly, begin to die from the margins and finally fall away and young pods fall or cease to develop. The disease often shows at isolated points in a plantation. The attacked trees should be felled and a trench dug around them about two feet deep and 16 inches wide at a distance of nine feet, throwing the soil inwards. This measure is carried out to prevent possible spread through the soil. Attention to drainage and forking should be given over the whole plantation.

THRIPS.

The leaves and pods frequently suffer rather severely from attacks of these insects, especially in dry weather. The leaves show brown patches and strips following the midribs and main veins, while the pod becomes russetted. The species in question (*Heliothrips rubrocinctus*) is easily recognised in the larval and pupal stages by the presence of a broad red cross band on the otherwise yellow body. The larvæ move about freely on the undersides of the leaves, puncturing the tissues with their beaks and sucking out the sap while the pupæ collect in small colonies and do not move. The adult insect is black with fringed wings. All stages may be found on the undersides of the leaves and the characteristic way in which the larvæ and the adults move about with the tail end raised and supporting a large drop of the bark liquid excreta can be seen easily. If the insects are not found, attack can be inferred from the b own strips and the small dark patches of the dry excreta scattered over the undersides of the leaves and pods. If marked injury is being done the leaves and pods should be sprayed with an insecticide, such as kerosene emulsion, the ingredients of which are cheap and easily obtained. The spray must be applied with force at close quarters from the finest nozzle and care taken to cover the undersides of the leaves. The work should be done in still air and all parts of the trees covered, but the spray should not be applied too long at one place as large drops may form, run down the trunk and injure the surface roots. It should be repeated two weeks later to deal with the next brood, as the eggs are not all killed by the spray.—Journal of the Jamaica Agricultural Society.

EXPERIMENTS WITH BUDDED AND GRAFTED CACAO

W. G. FREEMAN.

Success having been achieved in budding cacao, as has already been reported in this Bulletin, it is necessary to carry on the work on a commercial scale in order to ascertain whether budded trees will actually be of advantage on cacao estates. The mere fact that budding has been accomplished is of interest, but will be of no practical benefit to the planter if after a few years the only tangible results are a few budded trees in Botanic Gardens. The planter wants to see a fair sized area in budded plants under normal estate cultivation because it is only in this way that he can form a definite opinion as to the value of such trees in comparison with ordinary seedlings grown under similar conditions.

Amongst the data which must be available in order for him to arrive at a sound conclusion are the following :—

1. The practicability and the cost of preparing budded plants.
2. The season at which to bud, and whether budding is best done on plants grown in the nursery or raised at stake in the field.
3. The habit of budded trees ; whether they develop into low bushy plants or normal shaped tree.
4. The best planting distance compared with ordinary trees under similar conditions.
5. The power of resistance to drought, disease, etc., of budded trees.
6. The age at which they come into bearing.
7. The degree to which budded trees retain the characteristics of the parent tree, e.g., bearing capacity, kind of cacao, etc.
8. The yield of budded trees compared with ordinary seedlings.

With reliable information on these points it should be possible to obtain a correct answer to the vital question: Does it pay to form an estate of budded cacao in preference to the usual method ?

At the present moment this question cannot be satisfactorily answered. It is known that in some other cultivations in temperate regions budding or grafting (the two processes are identical in principle) is advantageous, and hence we can express the opinion that budding may be advantageous with cacao also. But this is not an answer to the question; it is an expression of opinion which may or may not be justified by results when the trial is made.

The work already accomplished at St. Clair shows that it is practicable to bud cacao readily under ordinary nursery conditions. But wood from selected trees is obtained at River Estate where the pod records are kept of some 10,000 trees. It is gathered in the morning, brought to St. Clair—about seven miles—and budding proceeded with the same afternoon. If the work is not completed that day, the bud wood is covered up with earth, when it remains in perfectly good condition for work on the next day. The whole operation is performed in the nursery, where the plants remain, demanding only ordinary nursery treatment, until thoroughly established. This is a great improvement on the procedure entailed in grafting by approach, when bamboo supports to hold the stocks have to be set up around the selected trees in the

field, and as these are often a considerable distance apart the necessary attention and watering during six weeks or two months are both troublesome and expensive.

In order to test the comparative merits on an estate scale of seedling, budded and grafted trees an experiment is being started at River Estate on lines approved by the Experiment Committee of the Board of Agriculture. (See Bulletin, xiii, 1914, p. 211.)

Ordinary shade.
- A. 1 acre cacao budded at stake.
- B. 1 acre cacao budded in nursery.
- C. 1 acre cacao seedlings.
- D. 1 acre cacao grafted.

No permanent shade.
- E. 1 acre cacao budded at stake.
- F. 1 acre cacao seedlings.

The planting distance throughout will be 12 feet by 12 feet.

In order to make the results a real test of the value of budded or grafted plants as compared with seedlings it is necessary that the buds and grafts should be taken from the same trees as those which supply the seeds. Accordingly the following trees have been selected on account of their bearing capacity over a period of four years, and the character of their cacao, i.e., they are all good type Forastero plants with an average annual yield of at least about 100 pods per annum.

A corresponding set has been selected for the Calabacillo stocks. Particulars regarding both are given in the following table :—

Selected "Forastero" Trees.			Selected "Forastero" Trees.		
No.	No. on tree on Estate.	Number of pods picked, 4 years average. 1910-11—1913-14.	No.	No. on tree on Estate.	Number of pods picked, 4 years average. 1910-11—1913-14.
1	79	140	24	2225	124
2	407	114	25	2314	114
3	556	120	26	2359	162
4	559	106	27	2394	105
5	969	111	28	2453	111
6	1097	165	29	2462	143
7	1114	114			
8	1139	174	Selected "Calabacillo" Trees.		
9	1158	95	31	2	117
10	1229	164	32	138	107
11	1278	174	33	199	116
12	1285	134	34	232	119
13	1304	127	35	337	176
14	1333	111	36	1281	123
15	1386	237	37	1290	105
16	1402	145	38	1347	110
17	1430	120	39	1416	78
18	1448	105	40	1464	141
19	1454	92	41	2107	143
20	1480	185	42	2170	112
21	2038	105	43	2271	129
22	2119	158	44	2298	181
23	2190	194	45	2408	184

In the two seedling plots, C and F., 10 pickets will be planted, with three seeds each, from each of the selected Forastero trees Nos. 1-29. Plot C will have ordinary permanent shade whilst plot F will not. The results from these plots will show to what degree seedlings retain the character and heavy bearing power of their parents.

In the plots of budded or grafted trees the stocks will be raised from seed of the selected Calabacillo trees, 20 pickets being planted with seed of each of the 15 trees in plots A and E., and a corresponding number of seedlings raised in the nursery for plots B and D.

Next year the stock plants so raised will be budded or grafted from the same Forastero trees which supplied the seed for the seedling plots, and in the same proportion. That is to say whilst plot C will have 10 plants raised from seed of tree No. 1, plots A. B. and E., will each have 10 budded plants from tree No. 1 and plot D, 10 grafted plants from the same tree ; and so on for the remaining selected Forasteros Nos. 2-29. In this way, if all goes well, reliable answers should be obtained to the questions the experiment is designed to solve. There will be seedling, budded and grafted plants, all of exactly the same age, and all derived from exactly the same known trees. They will be grown under similar conditions, and should it prove to be the case that budded or grafted plants come into bearing sooner than seedlings, and retain better the good qualities of their parents an important point will have been established. But the experiment should decide more than this, which could be determined with a few trees. It is for this reason that it is being conducted on a large scale, so that it may give the information which, as noted above, the planter requires in order to decide whether the ordinary method of planting from seed should give place to the use of budded or grafted plants. The deciding factor in this is the pecuniary result.—Trinidad and Tobago Bulletin.

COCONUT BEETLE TRAPS.

At the meeting of the Committee of Agricultural Experiments held at Peradeniya on March 11th, Mr. Bryce said that he had conducted some experiments with Dr. Friederichs' fungus preparing it in pure culture in tubes. Larvæ of the beetle (*Oryctes rhinoceros* L.) were obtained and placed in kerosene tins filled with palm refuse which was kept damp. The larvæ were inoculated by rubbing over them a platinum wire dipped in the spores.

On June 13th seven larvæ were inoculated : they were full grown and in healthy condition. On July 13th six were living and one had died : it showed no sign of fungus attack. Four of the larvæ were re-inoculated. One was dead on July 22nd, but showed no fungus. The other three were living on August 6th, and were dead on September 2nd, two of them having pupated. These last three were covered with the fungus.

Other laboratory experiments with larvæ kept in kerosene tins of palm refuse yielded similar results. It would appear, therefore, that the fungus is parasitic on the larvæ, but only weakly so. The fungus was cultivated on rice, and the rice with its thick growth of spores was added to larvæ in tins on October 20th ; on December 5th the larvæ were dead and covered with fungus spores. A large quantity of rice was prepared and the fungus grown on it in order to obtain sufficient material wherewith to infect the beetle traps in the field.

The traps were prepared on October 22nd and opened on February 19th. No larvæ were found : the control traps were also opened but contained no larvæ. Probably no beetles visited the traps to deposit their eggs.

TEA.

THE TEA TRADE IN 1914.

The feature of the year's trading has been, as with practically every other line of produce, the direct or indirect derangements caused, in the normal course of business, by the war. The earliest phase was a most active demand from certain members of the public, whose unreasoning fear led them to acquire large quantities of domestic supplies as a reserve against the possibilities of interruption in the ordinary channels of commerce. To this special demand was added, later on, a large requirement for the commissariat of the various fighting forces. The fear of inadequate market supplies for early requirements arising from (1) the sinking at sea by the enemy of certain large cargoes, (2) the difficulty of obtaining cargo space owing to regular liners being taken off for transports, and (3) the fear of capture causing vessels already *en route* to return to port or to delay sailings, led to a strong position being established in September and October. During these and later months an altogether exceptional amount of business was done with the nearer European countries, and it was considered that Germany was supplying herself indirectly through these channels. The extent of the business done is extraordinary. The annual tea consumption of Germany is about 9,000,000 lb., but the increase in the export trade from England recently has many times exceeded a demand based on such a total. The active tea merchants of Bremen, Hamburg and the East Friesland ports did a considerable export business. Their supplies from the East for carrying on their trade were, to a large extent, stopped on vessels either captured or waiting for safety in neutral ports. Further, direct importations were impossible; and the same applies to shipments for Denmark and Sweden, also to a certain extent for Holland. Russia's supply of tea has been cut off from the East. Consequent upon all these various considerations, London obviously has to supply all the demands more or less directly. Some of the tea is going to Russia by most expensive and hitherto untried routes, but it is necessary that it should go. It is not probable that there is any actual increase of consequence going on in the world's consumption outside Great Britain, and it is somewhat difficult to credit the allegation that the German Army is being compelled, in war time, to consume a beverage which has hitherto been drunk by only a small fraction of the population of the country.—Chamber of Commerce Journal—(Trade Review.)

EXHAUSTION OF THE TEA PLANT.

A correspondent sends us the following article from the Indian Planters' Gazette :—

" Is there a single species of the tea plant which has been produced by a prolonged system of cross-breeding with a definite end in view ?

All the *játs* of bush—unless I am much mistaken—have been naturally produced ready to our hand. Good and all as our best *játs* are there can be no doubt but that a great improvement could be made on the very best of them.

Plant breeding is not an occupation that any private individual could take up with the slightest prospect of ever having any return for his time and trouble. What he accomplished would benefit posterity, and the average individual is very much inclined to leave posterity to look after itself.

With Governments and public companies it is very different as their present prosperity and value in a great measure depends on their outlook not during the generation of their existence, which is a comparatively trivial matter, but on the generations of the future. The value of an investment depends more on its permanency than upon any other factor in its connection.

A well-known authority has expressed the opinion that the tea industry may last for fifty years or it may last one hundred and fifty, but sooner or later a new variety of the tea plant must be forthcoming or it is only a question of time till it becomes an unprofitable investment.

In all other branches of agriculture specialists are engaged producing hundreds of thousands of plants. They are grown to maturity and selections are made of all those showing characteristics of the qualities aimed at and the rest are destroyed. Re-selections are made again and again till only those nearest the desideratum in view are retained. These survivals are crossed and the same process gone over and over again, always keeping the particular point in view till at last the desired characteristics are secured. Even then the work is not finished.

The desirable characteristics which may have taken years to attain have to be tested and crossed and re-crossed till all the stability of a 'specially created species' has been fixed before the new plant can be confidently recommended or guaranteed to possess the particular virtues, which its predecessors may have lost. The present *jâts* of cultivated tea-plants must, some time or other, go the way of all intensely cultivated plants. It may be a longer or shorter time and it may come gradually or it may come suddenly but unless it is unlike all other cultivated plants it will give out some time.

Even in the event of its carrying on in its present state for an indefinite period which, judging from analogical reasoning is improbable if not impossible, every planter must admit that a much better plant might be cultivated than any we have under cultivation at present.

The Manipuri and Assam indigenous are superior, taking them all round, to the China bush. Still the China plant has qualities of its own that the so-called higher *jàts* do not possess.

For instance if our indigenous bushes would stand heavy pruning as well as the China it would be an advantage in itself well worth the devotion of many years of an expert's labour to attain. As a rule the more a plant is under intensive cultivation the shorter the life of that variety of plant will be. It has a tendency to get weaker and its constitution less able to stand up against the diseases and pests to which the species is naturally liable.

As our present tea plants are natural productions brought under cultivation they will stand longer than if they were artificially produced. But

the longer they are under cultivation the more intensive that cultivation is likely to be, and, consequently, the enervation of the plant will the more rapidly go on."

We are quite in accord with many of the remarks made in the above excerpt as we wrote at the time they first appeared, but we have again to express the opinion that as the work of creating a new *jât* of plant would entail very many years of the most patient toil, the subject is one of academical rather than practical interest. And it is rather doubtful whether in the end the new cross bred plant would prove superior to the natural best *jât* plants. The case of fruits and flowers is very different to that of leaves, as in the tea bush. We have often remarked that intensive cultivation is far more likely to do harm to the tea bush eventually than a less forceful one. The mistake—if mistake it is—will not be discovered for years to come. The desire to make the bush yield a greater quantity of leaf in the present is a greedy one, and it may be that we are letting go the substance in order to grasp the shadow. The tea bush, according to our present day methods, is being subjected to the most barbarous treatment and the wonder is how it has not succumbed ere this. What is really required is far more generous treatment. We keep on plucking and hacking it without intermission year after year without giving it an interval of rest. It is greed for returns that is likely to play havoc with tea plantations in the future. Shareholders demand dividends—the bigger the better. The old adage that "a little with contentment is great gain" is not acceptable to the majority of investors in tea. The result is that tea bushes are being plucked to death and sooner or later the inevitable result will be their collapse. The lesson that has yet to be learnt, that we are "killing the goose that lays the golden eggs," will be learnt in time, but not perhaps in our day and generation.

The following remarks are by our correspondent :

These words of warning give us food for thought, and lead us to consider whether we too are not "killing the goose that lays the golden egg,"—in other words living on our capital.

There is little talk of quality in these days, it is all quantity, and "greed for yield," each estate trying to outdo the other in yield per acre.

"Take care of the soil and the yield will take care of itself," is a good planting maxim.

1. Save it all you can from denudation by good draining.

2. Keep it in good tillage by frequent and good digging.

3. Add to it in mulch all the green stuff and humus you can lay hands on.

4. Apply small doses of manure to make good wherein the soil is deficient, and

Take the increase that Nature gives.

But this stimulating the bush into an unnatural yield by frequent and large doses of manure applied close to the bush, and increasing the yield beyond the point of safety, is, as the writer says, a questionable policy, and one for which we may have to pay the penalty at no distant date.

The question may be put briefly thus :—

Is there no limit to what Tea will do and do safely? or,

Is there a limit beyond which it is unsafe to go, without danger of trenching on reserves?

The wise agriculturist, if he wishes his children as well as himself to benefit, will fix the limit in his own mind, and work accordingly.

FIBRES.

COTTON IN SOUTH AFRICA.

H. W. TAYLOR.

In those districts where the soil and climatic conditions are favourable to the growth of cotton, farmers in South Africa will find that it will prove a remunerative crop for their non-irrigable lands. This has been demonstrated by experiments conducted by the Rustenburg Experiment Station of the Tobacco and Cotton Division of the Department of Agriculture, where eight varieties of cotton gave yields of more than 1,100 lb. of seed cotton per acre. Of these three gave more than 1,400 lb. and one variety went as high as 1,684 lb. of seed cotton per acre. Each of these varieties gave yields of more than 400 lb. of lint, and two gave more than 520 lb. per acre.

In the Cape Province most gratifying results have been obtained. Of six varieties tested in Pondoland in 1911, five gave yields of more than 1,000 lb. of seed cotton per acre, and one variety as much as 2,067½ lb. of seed cotton per acre.

Experiments are just being established in Natal, but from previous results it may be said that cotton is a crop eminently suited to a large part of that Province. On the British market practically every consignment of South African cotton has realized higher prices than American cotton of similar types.

The soils which give the best results are sandy and clay loams and alluvial soils. Considering the irregularity of the climate in South Africa, the crop is not so certain on light sandy soils, on stiff clays and on turf soils, in the latter of which cotton germinates badly during dry seasons. Since cotton is planted in October or November, it is necessary that the rainfall during these months and December be sufficient, or else a full yield will not be obtained; these three months may therefore be considered the critical period of cotton cultivation in South Africa.

Among the staple crops grown in South Africa, cotton is the least exhaustive of soil fertility, as may be seen from the accompanying table, which gives the amounts of plant food removed from the soil by various crops.

Crop.	Nitrogen lb. per acre.	Phosphates lb. per acre.	Potash. lb. per acre.
Cotton ...	21·36	10·97	9·21
Maize ...	73·74	23·96	63·06
Wheat ...	33·32	10·20	16·82
Tobacco ...	56·00	7·00	69·00

At the present time this Division is not in possession of sufficient data from all sections of the Union to be able to advise what varieties to grow in each of the several districts. From the results already obtained, it can be stated that for the greater part of the Transvaal the varieties of the big boll group, including Cleveland, Christopher, Russell's, Pullnot, Bancroft and

Bohemian, give the best results. In some parts of the Transvaal, where the soil is very fertile and the growing season long, the best results are obtained from Cook's Long Staple. This applies to the vicinity of Tzancen and the Brak River Valley. Along the coastal belt the best returns have been secured from the varieties of the long staple group, which include Cook's Long Staple, Nyassaland, Griffins, Sunflower and Allen's.

All the above varieties are annuals. The results obtained with the perennials have not, as yet, been sufficiently satisfactory to recommend their cultivation.—Monthly Bulletin.

FIBRE AT CAPE VERDE.

Agave sisalana was introduced into Cape Verde some years ago in the form of bulbils, which were distributed amongst the agriculturists in different localities. They appear to have struck wherever planted, but though they developed into good plants in the high lands and valleys, they were stunted in growth in the arid soils near the coast.

Fourcroya gigantea has been established in the wild state in the mountainous islands in the Cape Verde Archipelago for more than a century, and in some places it covers considerable areas. The fibre is prepared by the natives, but in such a crude manner as to render it unfit for export. In 1908 private enterprise attempted mechanical extraction with considerable success, the fibre being now sold in the markets of Hamburg, London, Antwerp, and Marseilles. In 1903 the Portuguese Government carried out experiments at the National Rope Factory (Cordoaria Nacional) with textile fibres from the colonies. *Fourcroya* fibre from Cape Verde was tested and gave good results.

On the initiative of the present Governor, important plantations of Sisal and *Fourcroya* have been established on certain State lands (Ruy Vaz, Cancello, Trinidad, at an altitude of 1,000 to 2,500 feet). At the beginning of April, 1914, 620,000 plants had been planted and 80,000 more will be planted before the end of the year. Since the bulbils require a considerable time to grow, plants which will begin to yield in three years and yield about one ton of fibre per 1,000 plants per annum after five years, have been bought from the natives. The present price of the fibre is £30 per ton.—Monthly Bulletin.

FRUIT.

FACTORS INFLUENCING MANGO CROPS.

Mr. A. C. Hartles, f.r.h.s., Superintendent of the Government Botanical Gardens at Saharanpur, contributes to the current number of the Agricultural Journal of India a useful article on the subject of mango crops, and some factors influencing them. The importance of the crop to India is, he says, such as to warrant investigation into its periodicity. Unfortunately no reliable statistics for the whole of India, are available to illustrate this point. The records maintained in the Government gardens at Lucknow, Nagpur and Saharanpur, which are summarised in the article, go to show that the malignant influences which effect the mango crop are : (1) Blight (due to insects) (2) Frost, (3) Heat and dry hot winds at the time of flowering, (4) Cloudy weather, excessive humidity, rain, and storms during the flowering period and (5) exhaustion following a heavy crop. Of the five causes of failure, four are external and one may be called internal or inherent to the plant. Of the four external agencies three are climatic, and therefore practically beyond control, but the last is open to be controlled. The observations of Mr. Hartles on the last factor permit of quotation.

EXHAUSTION FOLLOWING A HEAVY CROP.

The above is one of the causes given by more than one recorder. We may really call it the law of alternating fruit years. This is so well recognised amongst the cultivators that it is always taken into consideration when selling the crop which is usually done before the mango flowers. If this law was the only factor influencing the mango crop, we would no doubt have good years and fair years, in regular alternative succession. This law of alternation is recognised in fruit culture generally, especially in apples and pears.

I have elsewhere partially discussed the important question of alternating fruiting years, but its importance is a sufficient reason for again referring to it in some detail.

Bailey, in his book, The Principles of Pruning, lays down a law that—"Fruit-bearing is determined more by the habitual performance and condition of the plant than by the kind or extent of pruning. It is associated with a quiescent rather than with a stimulated or fitful state, and the habit is more amenable to treatment when the plant is young than when it is old." Under normal conditions it is natural that plants should fruit equally every year. Anything however that disturbs the ordinary equilibrium of the plant's life would react on the fruit-bearing habit. Some of the factors that may be responsible for such a disturbance have already been discussed. But there are many others, incidental to plant life, that would also have the same effect.

One important factor in this direction is overbearing. Bailey says, "overbearing is itself a disturbance of equilibrium, and is almost necessarily followed by a reaction or underbearing. This corollary has such an important

bearing on practice that it should receive careful attention. One extreme follows another, and the oftener these extremes occur the greater is the likelihood that they will become an unremediable or fixed habit of the plant. It is interesting to note that the habit of alternate bearing is most pronounced in plants of long life, suggesting that the habit is largely, if not wholly, the result of the frequent occurrence of overbearing while the plant was young.

Gorr, in an article on American Gardening on the "Origin and the Development of the Apple Blossom," gives some interesting suggestions which may equally be applied to mangoes. He says that leaf and flower buds are in a measure interchangeable. By proper pruning a flower bud may be converted into a leaf bud, and by ringing, a leaf bud may become a flower bud. Flower buds may be many years old before they form flowers. Any restriction of the movement of prepared food in the branches, such as is caused by ringing, or by a wrinkling of the bark formed by the union of the fruit spur with the branch which supports it, tends to the formation of flower buds. Dry weather is also conducive to the formation of flower buds, since during such a period evaporation through the leaves is rapid and sap becomes concentrated and rich in prepared food. Flower buds are then formed in portions of the tree where there may be no restrictions for the movement of the sap, as at the end of young shoots, etc. Whenever the water-supply is increased the tendency is to wood-growth and the formation of leaf buds. A normal growth is accompanied by a normal formation of flowers. When the fruit spurs of healthy trees push into growth or sap-sprouts start freely from the old wood growth is abnormal and fruit production is postponed. Investigations show that as active wood and leaf growth ceases, the formation of flower buds begins and may continue until cold weather sets in. During very favourable seasons for the formation of flowers all the 1-year, 2-year, 3-year old buds, many older buds, and some buds formed during the year, may form embryo flowers. This explains why an excessive fruit crop is always followed by a scanty one.

The above conclusions drawn from investigations on the apple apply equally to the mango. To illustrate the plausibility of the assertion that flower and foliage buds are interchangeable, I have seen cases in the mango which show great irregularity in the differentiation of flower and leaf buds. In some cases, foliage leaves were intermingled with the flower branches of the inflorescence, in others, foliage leaves had developed at the end or apex of the inflorescence. In the latter case although fruit may set, yet it usually does not develop. It would appear that weather conditions have a predominating influence, especially at about the end of the monsoon. The finest year for mangoes that I have seen followed an early closing of the monsoon. There is therefore some reason in the saying that what is good for a bountiful mango crop is not good for agriculture generally. This has been physiologically explained in the summary of the article by Gorr previously quoted. In the case of trees that are amenable to pruning, the alternating effect of an exceptional year can be controlled to some degree by this practice, but in the case of an evergreen like the mango, this is not feasible. The only alternative therefore is the thinning of the crop. What takes place in the mango is similar to that of the apple, only that a terminal shoot takes the place of the spur of the apple. It is simply a question of conservation of the energies of the tree. The demands upon a shoot when bearing a fruit are so great that

another fruit bud cannot develop the same year: what follows is that immediately after fruiting, some short shoots start from below the fruiting stalk. These are generally in a cluster around the end of the fruiting shoot. They develop more or less according to the season, during the same year as the shoot flowered. The succeeding year these shoots or some of them develop further and continue growing until checked by the closing of the rains. If dry warm weather follows, these shoots ripen or mature, and flower buds form. If, however, moist weather continues until the cold weather arrives, these shoots still continue to grow, and produce no flower buds; and it is this latter contingency that is to blame for some conspicuous "failure" years. This particular contingency is probably beyond our control, but the effects of the law of alternative fruiting years, which no doubt influences all the disturbing factors discussed, can be modified.

1. Thinning the crop is the most obvious method. But to be effective all the fruit or better, the blossoms from selected shoots must be removed. This would induce such shoots to start at once into growth with a possible chance of being developed and matured that year.

2. Thinning out the shoots of the growing year would throw more strength into those left. I have already explained that at the growing period of a shoot a number of young shoots are thrown out, below the fruit, it is to these shoots I refer particularly.

3. Some branches remain non-fruiting for some years. It is possible that a judicious heading in some of these yearly would induce stronger growth to take place, followed by fruiting the following year. The mango is, as we know, not amenable to much cutting, but can stand a little, and this may be taken advantage of in the way suggested.

4. In the case of large orchards, some trees may be altogether deprived of their flowers. This would induce them to alter their fruiting year, so as to have some trees bearing every year.

5. Lastly, as the whole question is chiefly that of food-supply, every endeavour should be made to keep the trees in as healthy a condition as possible. As a rule the mango, after it once begins to bear, gets little or no attention beyond watering. Much has yet to be learnt about providing additional food materials. There is no doubt that good tillage and some judicious manuring would contribute largely towards enabling the exhausted trees to recoup themselves annually instead of biennially, as is now the case. But it should be remembered that although such means as above suggested may change or help to change the alternating fruiting year, yet it is also true that the trees tend to revert to their accustomed habit, and it is probable that this reversion is the more rapid and the more complete the older the tree, and the more indifferent the general treatment of it.—Agricultural and Co-operative Gazette.

SOILS AND MANURES.

THE UNEXHAUSTED VALUE OF MANURES.

A. D. HALL.

A set of experiments was started at Rothamsted in 1904 in order to obtain practical information on the duration of action of manures. It took the following form : for each manure five plots were set aside ; one was a check plot which at no time received the manure under investigation , of the other plots, one received the manure in 1904, but remained unmanured in 1905, 1906 and 1907 ; a second plot was manured in 1905, but not in 1906 and 1907, the third in 1906, but not in 1907 ; the fourth in 1907. Thus in 1907, by which year the experiment was in full swing, there was a plot that had been manured in that year, another that had been manured in the previous year, a third two years previously, and a fourth three years previously. In 1908 it was considered that the manure applied in 1904 to the first plot had been exhausted by the four crops grown with it, and the manure was renewed on that plot ; on the second plot it was renewed in 1909, and so on. The field was framed on a rotation of alternating corn and roots and contained eight sets of five plots as follows:—

Nitrogenous Manures :

1. Dung made from roots and hay only.
2. Cake-fed dung.
3. Shoddy (wool waste).
4. Peruvian guano.
5. Rape dust.

Phosphatic Manures :

6. Bone meal.
7. Superphosphate.
8. Basic slag.

Once during each rotation a dressing of superphosphate and sulphate of potash was applied equally to all the nitrogen plots ; similarly for the corn crops a dressing of sulphate of ammonia was given alike to all the phosphatic plots. The unmanured plot in each series so placed in the line that together they formed two diagonals across the field, and the mean of the first five was used for comparison in the case of nitrogenous manures ; the mean of the last three as the standard for the phosphatic plots.

The results are considered under three headings.

I.—RESIDUAL VALUES OF RICH AND POOR DUNG.

In the year of application, the cake-fed dung showed a great superiority over the roots and hay dung, but this superiority was much less manifest the second year and entirely disappeared the third and fourth year, though the effect of the dung persisted in both cases, raising the yield above that of the unmanured plot. These results are due to the fact that both kinds of dung contain approximately the same amount of insoluble nitrogen, while the cake-fed dung is richer in ammonia and amides, the effect of which had completely disappeared after the second crop.

II.—OTHER NITROGENOUS MANURES.

The relative total produce of the other three nitrogenous manures is given below, the unmanured plot in each case being taken as 100 :—

	Year of application. — Mean of 9.	1 Year old Residue. — Mean of 8.	2 Year old Residue. — Mean of 7.	3 Year old Residue. — Mean of 6.
Shoddy ...	139·7	125·2	116·1	106·7
Peruvian guano ...	150	101	96·5	91·4
Rape dust ...	136·2	100·4	100	94·4

A marked contrast exists between the shoddy on the one hand and Peruvian guano and rape dust on the other. The shoddy evidently contains compounds of nitrogen subject to comparatively slow decay, so that its effect in the second and succeeding years is considerable, there being a distinct increase indicated in the fourth crop grown with the manure. Indeed, the values yielded by shoddy compare very closely with those obtained with farmyard manure made from roots and hay only. It is a persistent manure that exerts in the first year of application less than one-half of its total effect. Doubtless we should include in the same category all manures made from hair, fur, skin, silk, hoofs, horns, etc., and probably also the nitrogen compounds of bones.

Very different are the results yielded by Peruvian guano and rape dust. For both these manures the return in the first season is high ; they are well-known as active and effective nitrogenous fertilizers ; but the experiments show that they leave no residue possessing any value for succeeding crops. Owing to the limited number of experiments, too much stress cannot be laid on the actual figures obtained, but it may be concluded that the nitrogenous residue from Peruvian guano or rape cake after a crop has been taken will give less than 10 per cent. increase in the second crop, and after that will be completely exhausted. (It could be noted that this statement applies to the nitrogenous part only of these manures, not to the phosphates they contain.) Now the nitrogen compounds in question are, in the guano, ammonium compounds, uric acid and its derivatives, and some proteins ; in the rape cake, almost entirely proteins ; and it is a point of great importance in this connection thus to find that proteins are as active and as temporary in their action as ammonium compounds. Such a result is indeed intelligible, for the true proteins are readily and completely digestible, are equally easily attacked by bacteria, and pass thereby into ammonia and kindred bodies with great rapidity. There is other evidence from the Rothamsted experiments that the nitrogen in rape cake is, pound for pound, very nearly as immediately effective as the nitrogen in ammonium salts. The proteins thus fall into line with nitrates, ammonia, area, etc., as compounds which produce all their effect in the season of their application, and leave little appreciable residue behind, in contrast to the collagens (the insoluble nitrogen compounds of wool, skin, bone, etc.) and to the indigestible residues of food. With this distinction in mind, the residual

value of the nitrogen in other fertilizers can be thoroughly estimated ; in cakes and seed residues it will be present in the form of proteins : in fish guanos, it will be mainly protein ; in meat guanos, protein and collagen, the latter predominating the poorer the manure becomes and the more it approximates to bone meal. Though these conclusions are based on experiments on the Rothamsted soil alone, it is one that would usually be considered retentive of manure, being both heavy and cool, fairly supplied with rain but not waterlogged.

III.—THE PHOSPHATIC FERTILIZERS.

The following table shows the relative total produce yielded by the three phosphatic fertilizers, the unmanured plot in each case being again taken as 100.

	Year of application. — Mean of 9.	1 Year old Residue — Mean of 8.	2 Year old Residue. — Mean of 7.	3 Year old Residue. — Mean of 6
Superphosphate ...	116·2	109·1	113·8	107·8
Bone meal ...	114·6	112·4	109·1	105·6
Basic slag ...	114·5	110·5	104·8	112·0

These results are significant in two directions : (1) that the phosphatic manures persist in the soil, and the residues exert an effect roughly proportional to the amount of phosphate unused : (2) that superphosphate is as lasting a manure as either bone meal or basic slag. These conclusions are perhaps limited to a soil like that of Rothamsted reasonably well furnished with carbonate of lime, so that the compounds formed in the soil by the soluble phosphoric acid will be mainly those containing lime. With regard to the original object of these experiments, it is clear that the compensation to be paid for a dressing of phosphatic manure must be spread over a longer period than that given for most kinds of nitrogenous fertilizers.

Phosphatic manures are usually applied in considerable quantity ; with the ordinary dressings it may be assumed that at least one-half of the original value of the manure remains in the soil after the first crop has been taken, and compensation to that extent should be given to the outgoing tenant, always assuming that the soil is one needing phosphatic fertilizers, so that the original expenditure was justified. When phosphatic fertilizers are used on suitable grass land, the scale of compensation should be even higher and should last for more than four years, because of the cumulative change wrought in the herbage as well as the phosphoric acid left behind.—Monthly Bulletin.

STORAGE OF WATER IN THE SOIL.

Research Bulletin No. 5 of the Agricultural Experiment Station (Nebraska) contains an interesting account of the results of experiments carried out by Mr. W. W. Burr on the relation of water to soil. Although the detailed results apply only to the soils which yielded them, yet the general tenor of the conclusions displays truths the appreciation of which is essential to profitable cultivation. In the Nebraskan soils which were examined the maximum water which they can hold is from 16 to 18 per cent. of the dry weight of the soil. When the water is reduced to 7 to 8 per cent.—that is, when the soil has lost half of its total possible water—crops are unable to obtain moisture from the soil. To restore water to the soil summer tillage is the most efficient means, and from 10 to 33 per cent. of the seasonal rainfall may be conserved by this means. It is found that an inch of rain falling on a dry surface does not wet more than the top 6 inches of soil, and hence the water of a shower is useless for water-storing purposes unless the surface of the ground is already moist. Cultivation helps the storage of water; not only does cultivated land hold more of the rain than is held by uncultivated land, but when rain is heavy the difference increases considerably in favour of the cultivated ground. A mulch of several inches of hay or straw is more effective than a soil mulch for storing water. A mulch of 3 inches deep is more efficient in reducing surface loss of water during a dry spell than is a shallower mulch.—Gardeners' Chronicle.

EFFECT OF QUICKLIME ON SOILS.

H. B. HUTCHINSON AND K. MAC LENNAN.

To make a further study of the hitherto not fully known mechanism of the changes wrought by caustic lime in the soil, five soils of widely different type were taken :—

1. *Rothamsted soil*, a poor stiff clay containing 7·72 per cent. of organic matter (loss on ignition) and 1·94 per cent. CaO.

2. *Chelsea soil*, a black sandy soil containing 14·32 per cent. of organic matter and 1·42 per cent. of CaO.

3. *Craibstone soil* (Scotland), a light soil, rich in organic matter (14·55 per cent)., with 0·41 of CaO.

4. *Milbrook soil* (Woburn), a very light sandy soil, poor in organic matter (4·46 per cent)., with 0·26 of CaO.

5. *Woburn soil*, an open sandy loam, which has been rendered distinctly acid by annual applications of sulphate of ammonia for the last 37 years; it contains 4·58 per cent. of organic matter and 0·56 per cent. of CaO.

LABORATORY EXPERIMENTS.

The soils were passed through a 3 mm. sieve and filled into bottles in lots of 900 gms. A set of bottles from each soil was set aside as control, and the others received calcium oxide in the proportion of 0·1, 0·2, 0·3, 0·4, 0·5, and 1·0 per cent., while calcium carbonate was added to another lot to the extent of 1·0 per cent. with the exception of Craibstone soil, where applications of 0·3, 0·6 and 0·9 per cent. of carbonate were made. The water content was made up by means of sterilized water to 18 per cent. A set of bottles was

taken immediately after the end of this ten-days' treatment, and the others were stored, provided with cotton wool plugs, at room temperature. The various soils were examined once a month; the number of bacteria was determined, as well as the amount of ammonia and nitrates produced. Examinations for protozoa were also made.

POT EXPERIMENTS.

The soils were passed through a 3 mm. sieve previous to being filled into glazed earthenware pots (in which loss by drainage was prevented) at the rate of from 8 to 10 kg. of soil per pot. Lime as oxide and carbonate was applied in the same ratio as in the laboratory experiments. The surface soil was then wetted with 100 cc. of water in order to allow of efficient action of the caustic lime before it became carbonated. Ten barley seeds were sown in each pot, and after about a month the plants were thinned out to five per pot. Equal numbers of the seedlings were weighed to ascertain the initial effect of the lime on plant growth.

The results are given in numerous tables and diagrams and are summarized as follows:—

(1) A partial sterilization effect.

(2) A chemical action, decomposing some of the soil organic matter.

The amount of caustic lime necessary to induce specific changes in the flora and fauna of the soil depends very largely upon the character of the soil. The light sandy Millbrook soil, poor in organic matter and in carbonate, reacted sharply with 0·2 to 0·3 per cent. caustic lime; the Rothamsted clay soil, poor in organic matter but rich in carbonate, was found to react to 0·3 to 0·4 per cent; the acid Woburn soil required between 0·5 and 1·0 per cent., as did also the rich Chelsea garden soil, which already contained carbonate; the Craibstone soil, with a high organic and a low carbonate content, failed to react even to applications of 1·0 per cent. caustic lime.

Each of these soils, as well as many others examined, appears to absorb directly a definite amount of caustic lime, and until these requirements are fully satisfied the partial sterilization phenomena do not set in. These phenomena include a sudden initial decrease and subsequent increase in the numbers of bacteria, the extinction of the larger forms of protozoa and the inhibition of nitrate production. Lower doses than those required for partial sterilization induce a temporary suspension of nitrification, and consequent accumulation of ammonia, for periods varying with the amount of lime and the character of each soil, ; they also lead to a temporary increase in numbers of bacteria capable of growing on gelatine plates, but these afterwards decrease, until the level of the untreated soil is reached.

Caustic lime causes chemical breaking down of some of the organic matter of the soil, as shown by the ammonia formed during periods when bacteria are quiescent; when, however, bacterial growth commences, there is a large increase in the rate of ammonia production.

The return in nitrogen, as ammonia and nitrate for each increment of lime applied, varies with the character and reaction of the soil and the carbonate content. On the average, and within a period of about 250 days, it amounted approximately to 1·0 per cent. by weight of the caustic lime applied. Carbonate gave less returns, apparently because of its relative inaction on soil organic matter.

The pot experiments show amounts of available nitrogen in the soils comparable with the amounts of ammonia and nitrate produced in the laboratory experiments. In some cases the amount of caustic lime applied was sufficiently large to check the growth of bacteria and to depress plant growth in the first crop, but in the case of the Chelsea soil the bacteria were active but plant growth was depressed, a phenomenon not yet satisfactorily explained.

As in other experiments, inhibition of nitrification resulting from applications of lime leads to a higher nitrogen content in the plants. This has been ascribed to the assimilation of nitrogen compounds other than nitrates, and, of occurring to any extent, involves an uneconomic utilisation of soil nitrogen. Where the amount of lime does not check nitrification, as in the case of the lighter dressings of the Craibstone soil, the nitrogen content of the plants is about normal.—Monthly Bulletin.

INOCULATION OF SOILS.

The writers conducted at the Swedish Moor Experiment Station at Jonkoping comparative inoculation experiments with inoculated earth, with earth cultures of Kuhn's Nitragin, with earth cultures of Simon's Azotogen, and with Earp-Thomas' American Farmogerm. The experiments were carried out in a green house in unglazed stoneware pots, each of which was filled with 33 lb. of virgin undecomposed sphagnum peat fresh from the pit, all precautions having been taken to prevent any infection by contact.

For every special inoculation, five parallel plots had been prepared and manured at the rate of 4,460 lb. of slaked lime, 357 lb. of superphosphate, and 357 lb. of 38 per cent. potash salts per acre.

The plants grown were yellow lupins. The seeds were sterilized by being steeped for five minutes in 90 per cent. alcohol and then dried aseptically. The lupins developed quite normally and yielded the following amounts of green stuff per pot :—

Not inoculated	347	gram
Inoculated with inoculated soil ...	541	,,
,, ,, Nitragin	583	,,
,, ,, Azotogen	601	,,

The effect of inoculation was thus very marked, and the yield of lupins was nearly doubled. On the average Azotogen gave the best, while Farmogerm gave the smallest results. The difference between the first three substances was so small, that considering also the differences in the parallel pots, it is not possible at present to give the preference to one rather than to another.

The examination of the roots showed that Farmogerm had caused much less abundant formation of nodules than the other substances employed —

Monthly Bulletin

CO-OPERATION.

RURAL CREDIT IN AMERICA.

There is a general impression that our financial arrangements do not satisfactorily cover the rural communities and that there is need of better credit arrangements for farmers. The interest is widespread.

It is, of course, requisite that a credit foundation exist; that there should be the usual combination of character and security, but even where these conditions are satisfied the situation is still unsatisfactory. The suggestion of the formation of farmers' credit unions merits serious consideration. The aim of such organisations is not to supply a new banking system, but rather to establish a credit foundation or to utilize a collective goodwill which does not exist so long as the farmer acts individually. In this field Europe has developed beyond us. To what extent their institutions can be followed here needs serious study. It is probable that the unlimited liability feature of some of their schemes will not appeal to American farmers in most sections of the Union. Nevertheless, in those parts of the country where the system of merchants' advances to farmers has brought a great many borrowers into the relation where their individual liabilities to the leaders is already unlimited, it would not seem to be revolutionary to encourage the establishment of local co-operative credit societies and to transfer the features of unlimited liability of the borrower to a group of producers.

The main thing is to develop, either through individual or group action a credit foundation and a form of security which will attract existing capital, partly perhaps through existing agencies.

In taking action in this field of rural credits it would seem desirable that we bear certain guiding principles in mind. There does not seem to be any real demand or need for action which would do more than provide as adequate financial machinery for the rural districts within practicable limits as is provided for other sections. There does not appear to be need for unique legislation or for legislation which shall aim to give the farmer credit on easier terms than other members of society secure. What is needed is the creation of conditions and machinery which shall enable him on similar credit foundations to secure money at the same rates as those that prevail for other classes.

—Report of the Secretary of Agriculture, U. S. A.

DRUGS.

GINSENG.

AN IMPORTANT DRUG IN CHINA.

Few planters probably have heard of the plant known as "ginseng," much less experienced the wonderful medicinal properties for which it has long been famed. Yet to millions of people in China ginseng is a household word and the elixir of life. Occasionally the subject crops up for inquiry, and information is desired of a kind not readily accessible. About twelve years ago something akin to a boom in ginseng occurred in the United States, where the rosy prospects of a new industry were rather loudly proclaimed, but the chief result benefitted persons who had seed or plants to supply, rather than the farmer. Ginseng cultivation is a Government monopoly in Corea, as cinnamon was once in Ceylon, and the fabulous price of the article is maintained by regulating the crop. The dried roots form the chief article of export from Corea to China, amounting in value to some quarter of a million pounds sterling annually.

BOTANY.

The plant is known to botanists as *Aralia quinquefolia* (sometimes as *Panax quinquefolia*), and belongs to the Natural Order *Araliaceæ*, a family chiefly noted for ornamental and beautiful cut foliage. It is a low herbaceous perennial with palmate serrate leaves and tuberous roots, the small greenish flowers being produced in a loose umbel and borne on a short stalk. A native of Corea, Chinese Tartary and North America, it inhabits shady localities in the mountain forests of these regions. The Chinese name for the plant is "yansam," the North American "garanbouges," and the Japanese "Nijin."

There appear to be at least two distinct varieties of the plant, these differing in the leaves and shape of the root; the five-leaved variety is considered the genuine and more valuable one, the other, which produces roots of a smaller size, in a cluster, and has the leaflets in threes, being of little commercial value.

HISTORY.

In the former country the roots, which bear a fancied resemblance to the human form, have been gathered as an invaluable drug from time immemorial. In 1709 the Emperor of China gave orders to 10,000 Tartars to go in quest of the root and to bring as much as they could find; every one was to give two pounds of the best to the Emperor, and to sell the rest for the same weight of fine silver. Roots of a very fine quality have been known, however, to sell for as much as their weight in gold. From this will be understood the very high esteem in which the plant is held among the natives of China, Corea, and also Japan. These attach to it miraculous powers of healing and rejuvenation, with a sincerity and a faith almost amounting to veneration. The aphrodisiacal properties of the plant are not the least of its attributes, and this is a characteristic not uncommon among Eastern races, who invariably attribute such powers to certain plants of their own country.

GINSENG (*Aralia quinquefolia*)
A historical medicinal plant.
(*See page 252*).

LAC OF COMMERCE.
As produced on twigs by a scale insect, *Tachardia lacca*.
(*See page 259*).

SUPPOSED PROPERTIES OF ROOT.

Eminent physicians of China have written volumes on the medicinal powers of this plant, asserting that it "gives immediate relief in extreme fatigue, either of body or mind, that it dissolves obstinate humours, and renders perspiration easy, strengthens the stomach, promotes appetite, stops vomiting, removes hysterical and all nervous affections, giving a vigorous tone of body, even in extreme old age."

The roots are said to enter into almost every medicine used by the Tartars and Chinese, and are worth their weight in fine silver. Osbeck, the traveller and botanist, said that he never looked into the apothecaries' shops but they were selling ginseng, that both poor people and those of the highest rank made use of it, and that they boiled half an ounce in their tea every morning, as a remedy for consumption and other diseases. The root is slightly bitter and aromatic, and though it is admitted to have some tonic properties European medical men regard it as of no medicinal value.

DOCTORS DISAGREE.

It is remarkable however that the virtues of ginseng find few or no believers outside the native home of the plant. It does not find a place in the British Pharmacopœia nor in Greenish's recent publication, Materia Medica. Hanbury's and Fluckiger's Pharmographia mentions ginseng as being sometimes used in America for adulterating the medicinal root "Senerga." European and American physicians declare it has no therapeutic value. Yet it must be admitted that John Chinaman is not as a rule disposed to set fictitious value upon things, while it must also be remembered that many valuable discoveries had their origin in China. Dr. Sayegi, recently lecturing on the subject in Japan, stated:—

"The medicinal use of ginseng has been well-known for ages, but since the introduction of Occidental drugs its supposed properties have been disputed or discredited. This, however, is in many cases due to ignorance, for many people do not distinguish between ginseng and the common carrot, both being called Ninjin in Japanese. Yet ginseng has long been known as the divine and all-healing drug. Though the subject has undergone analysis by European and other scientists, I think it a matter of regret that it has not been more thoroughly investigated by local men of science.

"About 1903 I personally took up the study of ginseng, and obtained specimens of the Korean variety through the favour of Dr. Onaga. Two varieties of ginseng are recognized, viz.: the hill or wild ginseng, and the cultivated. Originally the wild kind was the only one used, but the supply has become exhausted by continuous collection, so that now-a-days a small piece costs as much as hundreds of dollars. Ginseng is now much cultivated and forms an important agricultural product, not only in Korea but also in Manchuria and Japan.

"The ginseng produced in the Koma province of Korea is the best, and is divided into "red" and "white" sorts, but these really possess the same properties and differ only in the process of preparation. Broken portions are graded as 'beards' and "tails.'

"The American ginseng is a different species from the Korean, but as the result of analysis Mr. Garieves, in 1854, found in the former a new ingredient

which he named panaquiron, and claimed that this substance is the principal active ingredient of ginseng. Panaquiron is a yellow substance which has a sweetish bitter taste. Mr. Rabensco, another investigator, extracted a substance which he called panatin.

"Formerly ginseng was used only as a decoction, but now the essence is extracted and may be obtained in the form of pills or powders. It is prescribed for Phthisis, Bronchitis, Gonorrhea, etc. From investigations made by me I have found it to have a most beneficial effect on the kidneys."

CULTIVATION AND COMMERCE.

Ginseng has been cultivated to some extent in the United States, the roots being exported to China, where they find a ready market and fetch the equivalent of about 8*s*. to 16*s*. per lb. according to size and quality. A few years ago it was held out as a promising minor industry which, however, in spite of the most glowing prospects of "get rich quick," failed to materialise and resulted chiefly, as has already been said, in benefitting the supplier of seeds or plants, which were disposed of at fancy prices.

From experiments made at the Pennsylvania State College, it was estimated that an acre of ground planted with ginseng would, after deducting all costs of planting and cultivation, in five years yield a net profit of over £3,000. This is on the assumption that the crop would produce a return of 2,900 lb. dry root, fetching about 34*s*. per lb. Such sanguine expectations, however, have apparently been found to be incapable of realisation. In Corea, it is stated, a plantation takes from six to eight years to produce a crop.

It is stated that the natural source of supply is becoming exhausted while the demand is increasing; but against this there is the fact that the out-turn of the cultivated product in Corea is only limited by the Government monopoly. The market value of the cultivated product exported from America to China is variously stated at from two to four dollars per pound. There is a certain amount of prejudice against the cultivated product, especially that imported from America, and it is impossible to predict the extent to which this might at any time develop.

The ginseng plant can be propagated by seed or tubers, and thrives best in rich humous soil. The soil should be dug deep and well pulverised, being cleared of roots, large stones, or other obstacles. The roots or plants may be planted at distances of about fourteen inches apart, in rows. The ground should afterwards be covered with a good layer of mulch or leaf-mould. The plants require to be shaded from the sun in summer and protected from the cold in winter. It is a very slow-growing crop, taking some four or five years to produce tubers of a marketable size. In Corea it is regarded as an exhausting crop, requiring periodical renewal.

The ginseng plant has been tried both in Peradeniya and Hakgala Gardens, and although it grew in both cases for a time it did not produce roots of any appreciable size, and finally succumbed. It is clearly not suited to a tropical climate, so that any planter who may have conceived a vision of producing nuggets of gold in the form of ginseng tubers, may at once dispel the illusion.

H. F. MACMILLAN.

ENTOMOLOGY.

CONTROLLING ATTACKS OF INSECT PESTS.

T. BAINBRIGGE FLETCHER.

On the sound principle that "prevention is better than cure" agricultural methods aim rather at checking any undue increase of crop-pests than at actual control after they have attained destructive numbers. Such methods are therefore extremely important and should invariably form part of the regular routine of the agriculturist. They include such means as clean cultivation, the proper rotation of crops, the growing of mixed crops, ploughing, changing the time of planting, the use of poultry and encouragement of insectivorous birds, the stimulation of plant growth by means of manures, irrigation and draining, the selection of resistant varieties of crops, and the use of attacked crops as fodder.

Clean cultivation, by which is meant the careful removal of weeds and wild plants from the fields and their adjacent areas, such as bunds and the removal of all crop-remnants after harvest, is by itself one of the most potent weapons in the cultivator's armoury in his ceaseless war against the ravagers of his crops. Not only should the field itself be carefully weeded before the crop is sown and while it is growing, but the buds and all similar adjacent areas should also be kept clear as far as possible. Many insect pests feed on wild plants and, having eaten up these or finding a succulent crop alongside and more to their taste, pass into the cultivators' fields and take their toll of the produce ; *Kumblihulas* are familiar examples of this and the ricebug *(Leptocorisa)* also commonly lives on wild grasses on the edges of paddy-fields until the paddy begins to come into ear, when that is invaded and attacked. Proper attention should therefore be paid to weeding not only in the field itself, but on the bunds around it and in any contiguous uncultivated area. A belt of open ground forms in itself an excellent defence against invasion from outside by pests such as caterpillars which are exposed to attack by various predaceous enemies (birds, ants) before they can obtain access to the cultivated area.

A very common practice in cultivation is to leave crop-remnants on the ground and this is a measure which is particularly dangerous in the case of cereals on account of the stem-boring insects which live on in the stubble and infect the next crop in the same or neighbouring fields. Cholam, ragi, paddy, wheat, and similar cereals are all affected by various stem-borers and it is a common sight to see a field in stubble from an old crop whilst alongside is a field growing a new crop of the same kind ; needless to say, all the pests carried over in the stubble of the old crop simply move across and attack the new one. Leaving a field in stubble often also encourages the increase of termites which are thereafter hard put to it for food and consequently attack the next crop grown in the field, especially if this is weakened by stem-borers which have also been carried over in the stubble.

As a general agricultural practice, therefore, I would advocate the collection and burning of stubble of all cereal crops immediately after harvest, the manurial value of the stubble being more than counterbalanced by the danger of carrying over pests. But in this, as in all similar practices, co-operation is essential: for, as pointed out above, it is of very little use to practise clean cultivation in one field if it is infected by adjacent or surrounding areas.

Leaving the crop itself too long in the ground is another form of the error noted above, and is also a fertile source for outbreaks of insect-pests. Cambodia cotton is an excellent example of this in Madras where, for the sake of a few extra handfuls of inferior lint, mostly spoiled and stained by insect-pests, a cultivator will often leave his crop standing in the ground until it is time to sow the next year's crop, which is naturally badly infected at the very start by the pests carried on by the old crop; the proper practice of course is to pull out and burn all the old crop at least three or four months before the new crop is due for sowing in order that all the pests of the old crop may as far as possible be starved out during the interval between the two crops

The proper rotation of crops is a matter of the utmost importance from the purely agricultural point of view, quite apart from the question of the control of crop-pests, yet at the same time it is an obvious and practicable means to the latter end also. Not only is it bad agriculture as a general rule to grow the same crop continuously in the same soil, but as pointed out above, such a practice is of direct assistance to the spread and increase of crop-pests. This again is a matter for co-operation between cultivators of adjacent lands as it is obviously of little use for one cultivator to rotate his crops if his new crop follow a similar one of his neighbour's and attracts all the pests which have lived in the latter. So far as pests are concerned also it is the rule not only that the same crop should not be grown continuously, but that naturally allied crops should not be grown. The potato and tobacco plants, for example, are closely allied to one another both belonging to the same natural order, so that pests which attack the one are especially likely to find suitable food in the other; ginger and turmeric, cotton and gogu, may also be cited, all the known pests of the one readily attacking the other of each pair.

The growing of mixed crops is a common practice in many districts; in the western talluks of Bellary, for example, five or six different crops (cereals, pulses, etc.), may often be seen growing intersown in the same field. In such cases the cultivator seems to distrust placing all his eggs in one basket, his idea being that, if one or two crops fail, he will at least secure a harvest from the others. But the plan is sound from the agricultural view-point of the varying requirements of different plants as regards the constituents of plant food available in the soil and the inter-relationships of the bacterial and protozoal fauna of the soil. There is no doubt also, that, if suitable mixed crops are grown, the increase of pests in each one is reduced, such reduction, in the case of drill-sown crops at least, being probably largely mechanical and due directly to the fact that each under one crop is separated from the next similar area by a barrier of other crops which are not suitable food plants for the pests of the former; a mixed crop

of groundnut and cumbu, for example, generally shows a much lessened attack on the former by the *Surul-puchi (Aproaerema nerteria)* as compared with that suffered by an unmixed crop of groundnut. The extra exposure of the moths when egg-laying and of the immature stages when hunting for more food undoubtedly forms a direct check on their increase.

Ploughing is of course an ordinary practice of agriculture but it is often no less effective in the control of insect-pests ; but for this end the ordinary country plough, which generally barely scratches the surface of the soil, is of little use and we require an iron plough capable of turning up the soil to a depth of at least six inches. The egg-masses of grasshoppers are usually deposited a few inches under the soil, and many caterpillars (e.g., *Kumbli-puchis)* also enter the soil to pupate and these egg-masses and pupæ often lie underground for months throughout the dry weather until the rains awake them to new life ; if, therefore the soil is thoroughly ploughed up at this time and large clods are broken as far as possible, most of these egg-masses and pupæ will either be brought up to the surface and killed by the sun or devoured by the insectivorous animals, or they may be buried so deeply that they are unable to emerge at the proper time and perish. Here again agriculture and pest control go hand in hand ; for ploughing during the dry season not only helps to check pests but, by providing a fine surface mulch, moisture is conserved to the subsequent benefit of the crop.

Changing the time of planting or of harvest when this can be done, either by sowing earlier or later, or by using early or late-maturing varieties of crop, may sometimes be used with success as a control measure in certain kinds of attack by insect-pests. A pest which appears at a particular time of the year, for example, may sometimes be defeated by delaying sowing until after its appearance or by sowing earlier so that the plants are sufficiently well-grown to withstand its attack.

The common domestic fowl and other domestic poultry, especially ducks, guinea-fowl and pea-fowl, are excellent and indefatigable insect hunters and their assistance in cultivated areas is not to be despised by the cultivator who wishes to obtain a good out-turn of crop. In areas such as cotton-fields especially fowls do excellent work in checking insects with mutual benefit to themselves and the cultivator. Very many kinds of wild birds also are largely or wholly insectivorous, and it suffices here to note that birds such as mynahs and drongos or king-crows spend their whole lives in capturing insects and should therefore be looked on as amongst the farmer's best friends and be protected and encouraged in every way. A few perches made simply of a cross-piece of wood fastened to an upright thrust into the ground amongst young crops will provide resting places on which birds, such as drongos, will be encouraged to sit ready to swoop on to any insect seen stirring amongst the surrounding crops.

The stimulation of plant growth by means of manures or other methods is another agricultural practice which helps to minimize the incidence and effects of the attack of crop-pests. A plant which is thoroughly healthy will often escape attack or will at least suffer comparatively little, whereas a sickly plant will be attacked far more readily and its produce will be reduced to a far greater extent.

Irrigation, where this is possible, is sometimes a good method of control of crop-pests even when the soil is not deficient in moisture. Crickets, for example, often do a great deal of damage to crops in some districts, living in burrows in the ground and only coming out at night to cut off tender shoots which they carry off to their burrows and devour during the day time ; in such cases irrigating the affected area will drive them out when they fall an easy prey to crows, kites, and various other enemies. The manner in which crows and kites will congregate when fields are being flooded is well known to every agriculturist and very little observation will show that they are busy catching grasshoppers, crickets and other insects which are driven out of cracks in the soil by the advancing water. Some caterpillars, beetles, bugs and other crop-pests may also be controlled by irrigating the affected area, but no general rules can be laid down. The addition of a bag of crude oil emulsion in the irrigation channel sometimes helps to drive any certain pests, temporarily at any rate. The converse of irrigation, *draining*, is used to control the paddy caseworm *(Nymphula depunctalis)* whose larva is aquatic in habit.

The selection of resistant varieties of crops is a subject which has hardly been touched in India but there is little doubt but that this line of work offers one of the most promising lines or research for the future. It is a matter of common observation to any agriculturist that particular plants of particular varieties of plants are less subject to attack by pests than are others grown under similar conditions, and by selecting and breeding from such resistant strains we may hope to secure relative immunity from the ravages of pests. This is not a matter in which immediate results can be expected and in the meantime agriculturists should retain seed for sowing from the most healthy and pest-resistant plants which they can select from their fields and should look on the selection of the best seed obtainable as the very foundation of any attempt to grow a good yield of crop.

In some cases, especially in cereals where a large area is placed under one crop and irrigation or other control methods are impracticable, small patches of a crop are sometimes found to be badly attacked by a pest. In such cases it is often possible to cut such patches and to feed the affected plants to cattle as green fodder, thus ridding the remaining areas of these centres of infection and at the same time making some use of the attacked plants. The use as fodder of *cholam*, etc., attacked by stem-borer will not hurt the cattle, but care must be taken not to feed hairy caterpillars *(Kumblipuchis)* or blister-beetles to cattle, as the effects of such a diet may be serious ; occasion may also be taken to point out the danger of hydrocyanic-acid poisoning consequent on a too liberal use of young actively-growing cereals as fodder, but it is probable that this danger will be largely reduced if only plants suffering from attack by insects are used.

The advantage of sowing crops by means of a drill and of planting out seedlings in regular lines become especially apparent in the control of crop-pests by means such as hand-picking. If a cotton field, for instance, is planted in regular rows, it is comparatively easy to go over the field row by row and collect cotton-bug, or whatever the particular pest is, and to be certain that no bushes have been left unexamined ; but it is far more difficult to make sure that no bushes have been missed out if they are planted irregularly. It is also far easier to notice the first stages of an attack in drill-sown crops and their intercultivation is more efficient and make it more difficult for pests to spread. Such crops too are more readily thinned out and the more vigorous plants which are left are better able to withstand the attack of pests.—Indian Agriculturist.

GENERAL.

INDIAN LAC IN CEYLON.

The introduction of the Indian lac insect (*Tachardia Lacca*, Kerr) into Ceylon has after many unsuccessful attempts been accomplished by the Ceylon Agricultural Society. The first consignment of brood lac for inoculation was received from Pusa in the latter part of 1912 and was used for inoculating Masan (*Zizyphus jujuba*) trees at Peradeniya and Maligatenna estate (near Kandy) and at Tangalle and Ambalantota. The inoculation was partly successful, but no brood lac was secured.

A second consignment of brood lac was received from the same source early in 1913 and was used for inoculating Masan and Kön (*Schleichera trijuga*) trees at Peradeniya and Kandy. The most successful development of lac was on Kön and Masan trees at the Maligatenna estate belonging to Mr. K. Bandara Beddewela, who has given much attention to the details of the experiment and kept careful records.

The last crop of lac was gathered from Masan trees in December last and the illustration accompanying this article will show how well it developed.

Specimens of stick lac were forwarded to the Imperial Institute as well as to Pusa and a sample sent for trial to the Kandy Art Museum, where lacquer work is done, was well reported on.

The Secretary of the Kandy Art Museum offered to buy the lac at Re. 1/25 per pound.

In order at least to meet the local demand efforts are being made to extend the cultivation to other centres and also to induce the lacquer workers in the Central and Southern Provinces to raise their own supplies of lac.

Messrs. Molegode and Nugewela (Agricultural Instructors) who have been deputed to this work since I severed my connection with the Agricultural Society have inoculated trees at Matale, Kurunegala, Colombo and Kandy. The development of lac in all these places is very satisfactory, and there is every reason to believe that the Indian lac insect has become naturalized in Ceylon.

To meet a demand for information on the details of cultivation the Society has decided to issue a leaflet on the subject in the vernacular for distribution among villagers: and the following notes jotted down as a basis for this leaflet are published for the benefit of members who are desirous of making trials with the lac. Further information will be found in the Tropical Agriculturist, Vol. 38 No. 2 (February 1912); Vol. 41, No. 4 (October 1913); and Vol. 43 No. 2 (August 1914).

Lac may be described as a resinous substance produced by a species of scale insect (Coccidæ) which lives on the young branches of certain trees. The insect imbibes the sap of the tree and exudes the resin which forms as an encrustation on the branches. The branches with this resinous encrustation are removed from the trees and the resin scraped off. This resin is called stick lac and when washed and dried forms seed lac. The shellac of commerce is prepared from seed lac.

PROPAGATION.

Propagation is done by inoculation, i.e. by tying sticks carrying brood lac to the young branches of trees in such a way that both ends of the stick touch the branches. The tying is done with plantain fibre or other suitable material. Brood lac is the lac as found on the sticks removed from the trees at the time the brood is about to emerge (as shown in the illustration). At this time a very tiny red insect is seen crawling about in masses. The object of tying the stick on to branches is to induce them to settle down in the tree. A few days after inoculation the insects begin to imbibe the sap of the tree and exude the resinous lac. When the branches are well furnished with insects the sticks should be removed to prevent over inoculation. In some cases the insects settle down in the branches in a few hours and in such cases the sticks should be promptly removed and the excess of brood used for other trees. As a rule insects continue to emerge for over two weeks.

SEASONS.

One cannot yet definitely say what the exact seasons are in Ceylon. From experience so far gained, it takes about six months for a crop to mature. Therefore two seasons in the year can probably be counted on. There are two seasons in India "Baisaki" and "Kartiki" similar to our "Yala" and "Maha." For the "Baisaki" crop, inoculation is done in October and the crop is gathered in June-July. For "Kartiki" crop, inoculation is done in June or July and the crop is gathered in September-October. One takes 8 months and the other 4 months respectively. But in Ceylon there seems to be greater uniformity, both seasons being of the same duration.

The following are notes of the dates of inoculation and harvesting in Ceylon :—

Inoculated	25th February	1913	and cropped	2nd August	1913
do	2nd August	1913	do	15th January	1914
do	15th January	1914	do	6th June	1914
do	6th June	1914	do	4th December	1914

LIFE HISTORY.

I may here say something about the life history of the insect. What is meant by maturity is the time required for the female insect to grow and lay eggs and hatch them. The insects are either male or female, and these can be easily detected under the microscope. After emerging and settling down on a branch, the insects as already stated get their nutriment by imbibing the sap of the tree and exude resin. This resin envelopes them and they remain incarcerated within it, breathing by means of the long whitish hairs (tubes) which emerge through the encrustations. After some time the male insect emerges from its prison while the female insect remains in *statu quo* and lays eggs which ultimately hatch out a tiny little red brood. It is at this time that the crop is ready for harvesting.

Three weeks before the emergence of the larvæ, the female ceases to feed and her body gradually shrivels up as she lays her eggs. Lac sticks may therefore be cut a fortnight before the emergence of the young insects without any harm being done.

SUITABLE TREES AND THEIR PREPARATION.

There are a variety of trees on which the lac insect thrives and in Ceylon we have the following :—

Kön (*Schleichera trijuga*)
Masan (*Zizyphus jujuba*)
Karanda (*Butea frondosa*)
Ingasaman (*Pithecolobium saman*)

The Masan and Kön appear to be the most suitable. As it is only on the tender branch that the insect can live it is necessary to prune the trees in time to produce a succulent growth. The Masan tree responds well to pruning and produces a copious supply of tender branches. At first the trees should be pruned about 4 months before inoculation; subsequently the removal of the crop of lac itself acts as pruning.

It would be very convenient if there could be two sets of trees. In this way trees inoculated during one season will be again inoculated in the third season, and the second set of trees will be ready to be inoculated with brood lac removed from the first set, and so on. In the absence of a sufficient number, however, the same tree may be used employing half of the branches in the first season and the other half in the second.

AFTER CULTIVATION.

After inoculating the brood lac sticks should be removed. Ants and caterpillars are some of the enemies of the lac insect. Care should be taken to keep them away. Tarring the lower stems of the trees and smoking are some of the preventatives employed.

CROPPING.

When the time comes for cropping the branches must be carefully cut and removed from the trees. These may be cut into small sizes of 8 to 12 inches long and left on bamboos for some days for æration before inoculation or put on to the trees at once. Branches that are not required for inoculation, may be scraped off for collecting resin.

SCRAPING AND WASHING.

After removal of the lac sticks from the trees the resin should be scraped off with a knife. If allowed to remain predaceous insects damage the resin and render it useless for commercial purposes. The scraped material, commercially known as stick lac, should not be exposed to the sun or be kept in gunny bags but should be treated at once.

This is done by crushing it into small pieces (if not small enough at first) and then washing so as to get seed lac, which, unlike stick lac, can be stored for a length of time. In washing, stick lac should be soaked in water for 24 hours and then put into an earthen or (preferably) iron vessel with a wide open mouth, mixed with water and either rubbed with the hands or trampled with the feet. After straining the water from the vessel and adding more fresh water the rubbing is continued. This must be repeated until the colouring matter or lac-dye is completely separated from the lac. Next a little washing soda at the rate of 1 oz. to every 10 lb. of washed lac may be added—an excess of washing soda will be injurious as it removes the wax present in the lac and makes it very brittle—and washing continued. When the last trace of colouring matter disappears the lac will have a pale orange colour, which is the proper colour of the seed-lac of commerce.

USES OF LAC.

Shellac is made out of seed lac. Mr. Misra, the Indian Lac Expert, gives the following uses of Shellac in his book on the subject:—

LOCAL AND FOREIGN USES OF SHELLAC.

Local.

(1) By goldsmiths for filling ornaments.
(2) For making bangles, marbles and toys.
(3) For making milk churns, shuttles and bobbins.
(4) For making bracelets and sealing-wax sticks.
(5) For making grinding stones.
(6) For fixing shafts to swords, etc.

Foreign.

(1) For gramophone records.
(2) As a constituent of varnishes and polishes for furniture and metals.
(3) Sealing-wax sticks.
(4) Lithographic inks.
(5) As a stiffening for silk and straw hats.

In Ceylon the lac is used for painted lacquer work of various sorts.

ENEMIES OF LAC.

Ants, predaceous caterpillars and parasites are injurious to the growth of lac, and care should be taken to free the trees on which lac is grown from them.

Lac dye can be used for dyeing wool, leather, Eri-silk and other silk.

N. WICKRAMARATNE.

THE SEEDS OF *TRICHILIA* FROM THE NIGERIAN SUDAN.

P. AMMANN AND J. VUILLET.

The various species of *Trichilia* have not yet been thoroughly investigated, although they yield various interesting products ; the bark of some of them is an excellent substitute for Ipecacuana, while their seeds contain varying quantities of fatty matter suitable for soap and candles.

M. F. Pellegrin, in a monograph on the Meliaceae of West Africa, enumerates 12 species of *Trichilia*, of which 6 belong to West Africa proper and 6 to Equatorial Africa. The six species belonging to West Africa are : *T. Prieureana*, A Juss ; *T. emetica*, Vahl ; and *T. Hendelotti*, Planchon—all of them small trees belonging to the savanna region ; *T. acutifoliata*, *T. candollei* and *T. cedrata*, all three described by A. Chevalier and forming large trees in the virgin forests of the Ivory Coast.

The seeds of *T. emetica* have been exported from Mozambique to Marseilles for a long time under the name of *Mafuraires*. It was therefore desirable to know if the West African products gave seeds of equal value. Seeds were therefore obtained from various species found between Bamako and Koulikoro and studied at the Chemical Laboratory of the Colonial Garden of Vincennes. The types of seeds were as follows :

I. Small dark red seeds.
II. Medium-sized seeds of orange vermilion colour.
III. Large orange-coloured seeds.

The results of the analyses are given in the following table :

Analysis of Seeds.	I.	II.	III.
Weight of 100 seeds, gms	12·7	29·4	79·1
,, ,, 100 kernels, gms	4·68	17·08	46·04
Percentage of kernels in seeds	36·9	58·1	58·2
Shells %	63·1	41·9	41·8
Moisture % in shells	6·42	4·16	4·74
,, ,, in kernels	5·73	6·71	5·76
Fat in shells	41·50	38·10	51·90
,, ,, kernels	30·10	44·70	43·70

The large seeds most nearly approach the Mafuraires from Mozambique as regards size and fat content. The medium seeds are identical with those of *T. Prieureana* preserved in the Kew Museum.

French West Africa should be able to export at least several hundred tons of the Mafuraire seeds each year.—Monthly Bulletin.

THE LONGEVITY OF SEEDS.

The longevity of seeds—a subject of perennial interest and great practical importance—is discussed in a communication made by Dr. Shull to the Plant World. Dr. Shull's communication deals with the longevity of submerged seeds, and recounts the results of experiments made at Cold Spring Harbour, New York. The experiments were suggested by the observation that owing to the bursting of a dam and the consequent draining of a pond a luxuriant vegetation sprang up within a few months on the dried and drained floor of the pond. It was known that the pond had not been drained for at least 70 years. Yet from out of the dried mud there arose in the spring some 140 species of flowering plants, many mosses, and at least one liverwort. Of the flowering plants a few were perennials, and of these an Aster and a Solidago flowered in the summer, and must, therefore, have grown from pieces of root-stock. In order to obtain information as to the provenance of the seeds, Dr. Shull started an experiment on December 13, 1905, wherein six lots of seed of each of 22 species of plants were placed in soil in large glass jars. The jars containing the soil were filled with water, were stored in a basement room, and water was added from time to time in order to make good the loss by evaporation. On July 1, 1907, 18½ months after the starting of the experiment, one of the jars was opened and the germination of the seeds which it contained was tested, with the result that in due course seedlings appeared on the following plants:—Cyperus spp., Juncus tenuis, Muehlenbergia diffusa, Plantago Rugelii, Sium cicutaefolium, Verbena urticifolia. A second jar was investigated two years and five months after the beginning of the experiment, and of the seeds which it contained the following germinated:—Chenopodium album, Lappa minor, Muehlenbergia diffusa, Plantago Rugelii, Sium cicutaefolium, Verbena urticifolia. After four and a quarter years seeds of 11 species were found to be viable, and in the last test, made seven years from the starting of the experiment, seedlings of Sium cicutaefolium, Juncus bufonius, and J. Tenuis were obtained.

Dr. Shull concludes from these experiments that the plants which made their appearance in the drained pond were derived from seeds which had found their way into the pond by natural agencies, had accumulated there, and had remained inert but unharmed in spite of a long submersion.

Another problem remains which Dr. Shull refers to but does not attempt to discuss. That problem is the means whereby the submerged seed is protected against premature and fatal germination. At first sight the moistness of the soil in which the seeds were lying would appear to be all against their dormancy, for, as everyone knows, a supply of water is an incentive to germination. The explanation of the dormancy of such submerged seeds appears to us to be provided by the remarkable experiments of Mr. Kidd, described by the author in these columns (Gardeners' Chronicle, Vol. LV., p. 186, and Vol. LVI., p. 34).

Mr. Kidd has shown that the presence of some 10 to 20 per cent. of carbon-dioxide in the atmosphere surrounding the seeds provokes a persistent latency. The seeds remain capable of germination, but do not germinate until they are restored to an atmosphere containing the normal low percentage of carbon-dioxide. We suggest that in submerged soil a similar condition obtains, that the water surrounding the seeds is saturated with carbon-dioxide and deficient in, if not depleted of, oxygen, and that, therefore, the seeds remain in a state of enforced rest—of suspended animation—so long as these conditions are maintained. How long life remains in such seeds has yet to be determined.

An interesting contribution to the general question of the longevity of seeds is made by Sir Herbert Maxwell in a letter to Nature (January 21, 1915). Sir Herbert recounts that his father, in 1862, drained Dowalton Loch, Wigtonshire. Among the plants which have taken possession of the

drained ground, Sir Herbert observed six years ago Pyrola minor in wide breadths. This plant is not known to Sir Herbert Maxwell as a present inhabitant of the county. Whence have the minute seeds come, and how have they found their way through the closely cultivated land to the site of Dowalton Loch? Sir Herbert Maxwell is such a keen observer and accomplished naturalist that we make with diffidence the suggestion that ants will prove to have been the transporting agents. That they carry minute seeds in considerable quantities over wide distances is known, and we believe that exact details of their seed-carrying operations were given some years ago by Professor Weiss, who perhaps may be able to give further information on the subject.—Gardeners' Chronicle.

THE CULTIVATION OF CHICORY.

A POSSIBLE SUB-TROPICAL PRODUCT.

In the past years the United Kingdom has relied chiefly on Belgium and, to a much less degree, Germany, for its supplies of Chicory (*Lichorium intybus*). The extent to which this has been the case will be seen from the following table, showing the imports in the three years 1911-1913 of raw or kiln-dried chicory:—

TOTAL IMPORTS OF RAW OR KILN-DRIED CHICORY.*

——	1911	1912	1913	1911	1912	1913.
	Cwt.	Cwt.	Cwt.	£	£	£
Germany ...	3,395	—	—	2,706	—	—
Belgium ...	84,274	87,263	85,836	69,810	51,460	36,802
Total...	87,669	87,263	85,836	72,516	51,460	36,802

Of the above total quantity for 1913 the amount imported for home consumption was 65,016 cwt. This must practically all have come from Belgium and might possibly represent the produce of nearly 2,000 acres. Although the imported chicory is in no way superior to the English-grown article, the cultivation of the crop in this country has fallen to a very low point, the area actually under the crop in England and Wales being 391 acres in 1912, 93 acres in 1913 and 77 acres in 1914. The gap left by the cessation of Belgium imports might be filled by an export trade from Holland and Denmark, but at enhanced prices, and there appears, therefore, to be some likelihood of a good demand for English-grown chicory. In view of the limited extent of the market, however, growers would probably be well advised to ensure a sale for the roots by obtaining an agreement from the dryer of (if several growers could unite to dry their own roots) the coffee blender.

SOIL.

A deep loam with a slight excess of clay is usually regarded as the best soil for chicory, though the crop often does well on light land that is not too

* Roasted or ground chicory was also imported, mainly from Germany and Belgium, to the extent of 4,460 cwt. (1913), representing about 120 acres. A certain quantity of chicory is also imported already mixed with coffee.

dry. The roots yield a larger proportion of dry matter when grown in a soil of good body than when grown on lighter land, although in the former case there is a larger expenditure of labour in lifting and washing the roots. Fen land and potato land seem to suit the crop very well, although it would probably not be profitable to substitute it for market-garden crops where the latter are doing well, especially where two crops can be grown in the year. An open and friable subsoil is necessary for the success of the crop.

VARIETIES.

There are two main varieties of chicory, viz: "Téte d'Anguille" or "Palingkop," which has few, crisp, much serrated and reddish veined leaves, and a long, regular root; and "Madgeburg" which has large, upright, lanceolate leaves and a longer root than Palingkop, the root being also thicker at the top.

PLACE IN ROTATION.

In Yorkshire, chicory used to follow either wheat or potatoes, and was occasionally grown for several years in succession on the same land. In France it is substituted for sugar beet, while near Madgeburg it follows sugar beet. As a result of the manuring and cultivation given, it may be followed by a cereal crop with good results. In Belgium it is usually followed by flax.

PREPARATION OF SOIL AND MANURING.

When chicory is to be grown on a corn stubble the soil should be lightly skimmed in October, well harrowed, and manured with 10 to 12 tons per acre of farmyard manure, which should be ploughed in 5 or 6 inches deep. The land may then be left undisturbed until April, when it should again be ploughed or deeply cultivated according to the character of the soil and climate, and worked into a fine seed-bed.

Deep working of the soil is necessary, as the tap-root of chicory penetrates to a depth of 15 inches or more. If the soil is thin or close-bottomed it will be an advantage to use the subsoil plough.

Dung is not usually applied after potatoes, but about 5 cwt. of artificials are harrowed in when the seed is sown in the spring. An application of 10 tons of dung in the autumn, and 1 cwt. nitrate of soda, 2 cwt. superphosphate and 1 cwt. sulphate of potash (48 per cent. pure K_2O) in the spring, might be tried; if no dung is used the artificials should be doubled. The quantities of artificials are less than those commonly applied in Belgium.

The application of dung in spring is not recommended, as it favours the production of foliage at the expense of the root, which is liable to be watery and forked, and have its aromatic qualities injured.

SOWING.

The land must be thoroughly clean, have a fine tilth, and be well consolidated before sowing. Belgian growers prefer the seed to be two to three years old, as it is held that plants from such seed are less liable to develop flowering shoots. The seed is drilled from the middle of April to the middle of May, at the rate of 3 lb. to 6 lb. per acre, in rows about 12 to 18 inches apart to allow horse-hoeing between the rows. The ridge system might be tried if the land is foul, 19 inches being allowed between the ridges, but it is better not to sow chicory on foul land. If sown too early the plants are apt to run to seed at the expense of the roots.

Where a farmer contracts to grow roots for a drying factory the manufacturer commonly supplies the seed.

CULTIVATION AND SINGLING.

After sowing, the land is sometimes harrowed; it is always rolled.

The first hoeing should be carried out at the end of May or the beginning of June, when the young plants show their fourth leaf, and a fortnight later the plants may be singled. The general opinion is that the plants should be left at least 6 inches apart in the rows; in France the distance is from 8 to 10 inches, and in Flanders the average is about 8½ inches. With thin seeding it might be possible to avoid the cost of singling. The plants should be singled by hand when the soil is soft with rain in preference to cutting with a hoe, as the roots are very tenacious of life and will throw out new buds even when cut a good deal below the surface.

Hoeing should be done once or twice at the end of June or the beginning of July, and be repeated so long as it is possible to get between the plants. In July the plants which are running to seed should be weeded out as their roots are woody and valueless.

HARVESTING.

Harvesting is undertaken when the leaves are yellow; it usually commences about the beginning of October and proceeds until frosty weather sets in.

Some growers cut the foliage of the plants in the summer for feeding to stock. This practice, however, must be condemned, since it is certain to retard the development of the root, but when the plants approach maturity the foliage may be gradually removed and utilised to mix with other fodder for dairy cows. The roots are dug with a fork or spade; care must be taken on heavy soils that the roots are not broken, and special lifters similar to those employed for sugar beet are sometimes used in such cases.

YIELD.

As regards yield, the average returns obtained per acre in Belgium in 1909, 1911 and 1912 were 12½, 11½ and 13 tons, while in Holland both in 1910 and 1911 about 9½ tons were obtained. In France the yield is stated to approximate to 12 tons per acre. An English grower who communicated his results to the Board stated that he obtained an average of 9 tons from 89 acres, the biggest yield being between 16 and 17 tons. If the roots are topped on the field the tops may be ploughed in; or otherwise they may be fed to animals in small quantities.

The roots may be washed on the field after harvesting, or washing may be undertaken at the kiln, especially where the roots are obtained from small growers.

COST OF CULTIVATION.

The expense of labour contributes to making the cost of cultivation high. From examples furnished to the Board in 1904 it was estimated that the average cost of cultivation after wheat was £15 per acre, viz:- Twice ploughing and harrowing, £1; seed and sowing, 10*s.*; manures, £4 10*s.*; hoeing and singling, £2 10*s.*; digging and washing, £2 5*s.* After potatoes there would be a saving of £3 per acre for manures and the labour bill would be less owing to the land being in better condition. An English grower who has recently made an estimate arrives at a cost of £10 2*s.* per acre, but allows only 6*s.* for manures. In France an estimate in 1908 was £12 per acre (12 tons of roots being produced); in Belgium £14 per acre seems to have been reckoned as an average cost.

It would seem that the cost of production per ton of roots is about 24*s.* The labour bill might be largely reduced if the cultivation of the crop were undertaken by small holders and their families.

DRYING THE ROOTS.

At the factory or drying kiln the roots are again washed, and afterwards passed through a slicing machine which cuts them into disc-like slices, about $\frac{1}{8}$ inch thick. The cut root is then taken to the drying chambers and spread in a layer on the floors, which consist of perforated iron plates arranged over coke fires. In the most simple form of kiln each lot of root is deposited on the perforated floor in a layer $9\frac{1}{2}$ inches to $11\frac{1}{2}$ inches deep, and is left exposed for 24 hours to the action of the hot air, which is kept at a temperature of about 140° F. During this period the mass is turned over with a shovel every two hours to prevent the chicory from burning and to make the drying as uniform as possible. The root so dried is known as "ordinary dried" chicory.

The quantity of roots produced on separate farms would probably be so small that it would be more profitable for an individual grower to send the raw produce to a central kiln, unless he could co-operate with other growers in the maintenance of a common kiln. "Ordinary dried" chicory yields on roasting from 90 to 92 lb. of ground chicory per cwt.

It was stated in the Board's Report on the Cultivation and Drying of Chicory (1904) that most Belgian growers had their own kilns, a small kiln with one or two fireplaces and hearths being built for £60-£80, while a large well-arranged kiln, with six fireplaces and two drying floors would cost about £240 to build.

When the chicory is sufficiently dried it is removed from the hot floors and put into linen sacks of loose texture, in which it is kept for some hours to cool; during this time it further dries and gradually hardens. It is then emptied from the sacks and stored in a heap in a dry, dark warehouse free from draughts. A small quantity of quick-lime is often placed in an unused corner of the warehouse to dry the air and to attract moisture from the chicory. Heating and deterioration in quality may set in after a few months if the chicory has been insufficiently dried.

It is usually reckoned that 4 tons of raw roots are needed to produce 1 ton of "ordinary dried" roots. In the Board's Report of 1904 the cost of producing 1 ton of kiln-dried roots in Flanders was given as £5 17*s.* 2*d.* (4 tons of raw roots were reckoned), and if £12 duty be added the cost comes to £17 17*s.* 2*d.*

If several small holders could combine to erect a kiln, or to use one already existing, so that they could dry their own roots, they would have the advantage of both growers' and driers' profits. On the other hand, it may in some cases prove advisable to contract with the drier or coffee blender before growing the crop.

Belgian chicory intended for export to the United Kingdom is nearly always subjected to a further process of drying in specially constructed kilns before shipment, the object of this second drying or "high-drying" being to make the article as light as possible and thus lower the Customs duty; kiln-dried chicory usually loses 20 per cent. of its weight after it has been "high dried." The operation of high-drying is, however, one requiring a considerable amount of care and skill in addition to the use of special kilns.

It has been stated recently by an English drier that if the crop is raised in autumn 5 tons of raw roots are required in England to produce 1 ton of "high dried" root, and if left in the ground till February, 7 tons are required.

The cost of producing 1 ton of "high dried" chicory, allowing for 5 tons of raw roots at the cost of production of 24*s.*, and a duty of £12 per ton, is given as £21 12*s.* 3*d.* This figure is made up as follows :— Roots, £6;

duty, £12. rent and rates, 7*s.* 6*d*; wages, £1 1*s* 3*d.*; coke, £1 3*s.*; oil, 2*s.* 6*d.*; seed, 6*s.*; superintendence, 5*s.*; bags, 4*s.*; carting, 3*s.*; total, £21 12*s.* 3*d.*

The drier in question heats up to 260° F. until the slices get quite crisp. This dried chicory, it is said, is equal in all respects to that produced on the Belgian high-drying system. The kiln, machinery for washing, slicing, etc., cost about £ 1,200.

The roots are cleaned by scraping and washing, split where they are thickest, and cut across in pieces about 2 to 3 inches long. Some nicety is required in drying to prevent the root from being scorched and to keep the proper flavour.

PRICES AND PROFIT.

At the end of January the price, duty paid, for "ordinary dried" chicory root was £39 to £40 per ton and for "high dried" chicory root £43 to £44 per ton; these are nearly double the prices paid in January, 1914. At these prices, and on the basis of the above figures showing the cost of production and drying, chicory should be a highly profitable crop.

Even supposing the cost of ordinary drying to be the same as high drying (and it should be much less), and the amount of raw roots required to produce 1 ton of dry by ordinary drying to be the same as that required by high drying (and it should be 20 per cent. less), the figures suggest that a very substantial profit would be obtained by growing an "ordinary drying" chicory, at present prices.

DUTY.

The excise Duty on chicory is 12*s.* 1*d.* per cwt., reckoned, not on the weight on delivery from the warehouse (chicory absorbing moisture during storage in the warehouse), but on the computed weight of the chicory at the time of its deposit in the warehouse. Even here, however, it will be seen that duty is paid on the water in the kiln-dried chicory at the time of its deposit in the warehouse, and if high-drying were generally adopted in England the effect would be to reduce the duty to an equivalent of £10 per ton of kiln-dried chicory.

Imported kiln-dried chicory is subject to a Customs duty of 13*s.* 3*d.* per cwt.; the advantage of 1*s.* 2*d.* per cwt. in favour of the home grower is supposed to off-set the trouble to which he is put by having to dry and store his roots under Excise regulations.—JOURNAL OF THE BD. OF AGRICULTURE.

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DATE PROPAGATION.

The rapid propagation of date offshoots is a matter of great importance at this stage of development of the date industry. Experiments now under way indicate that it is possible to root offshoots much more rapidly under greenhouse conditions where they can be given bottom heat than by the Old World method of procedure. It is believed that by this method much smaller offshoots can be rooted. It has also been found that when grown in the cool, moist climate of the Pacific coast in immediate proximity to the ocean, certain varieties of the date palm fruit scarcely at all, but produce instead very great numbers of offshoots and continue to produce them through a much longer period of years than in typical date-growing districts. It is planned to transfer palms of the choice new seedling varieties to such localities in the hope of thus insuring a larger number of offshoots than could otherwise be produced.—Annual Reports of the Department of Agriculture, U. S. A.

RAINFALL AND CANNONADING.

The record rainfall of last month (January) and its continuance has set many persons trying to find an explanation in the cannonading at the front. Some eight or nine years ago the theory was rather widely spread that heavy gun-fire caused rains, and, as at that time the autumn practices at such places as Shorncliffe, Portsmouth and Plymouth were often followed by heavy rain, there seemed to be some justification for the theory. So serious experiments were undertaken in Australia, where a severe drought was ruining the prospects of many graziers. But the experiment was foredoomed to failure, and it was discovered that although cannonading will cause rain clouds to burst, no amount of explosion will form the necessary clouds. When the records of the British Rainfall Association for last December are studied it requires a considerable amount of faith to accept the "rain and gunfire" theory. For it is seen that at the places in this country nearest to the scene of the firing the rainfall was slightest. At Margate, December's rainfall was less than 4 in., whilst London received over 6¼ inches. Moreover, it is seen that whilst the rainfall was of record amount at nearly all the stations, the East Coast was, as usual, the driest part of the Islands, and the Western counties were the wettest. In South Wales 19 inches fell and on Dartmoor 15 inches were recorded, but at Stye, in Cumberland, a notoriously wet county, 27 inches swamped the land. The most reasonable explanation of the abnormal rains is that Nature is balancing the drought of the previous summer. Although the rains may seem excessive, and in some places the floods have caused much inconvenience and great loss, yet the ground in some woods is still dry.—A. C. B. in Gardeners' Chronicle.

Experiments with ramie in several locations during the last year show that the plant will grow under irrigation on soils of rather firm texture, but not on light, sandy soils, and it has grown well on clay loams in Louisiana, Mississippi, and Maryland. In an experiment in decorticating the fibre, however, only 160 lb. of dry fibre (China grass) were obtained from about 16,000 lb. of green plants, including leaves, grown on ⅛ acres. This yield of only 1 per cent is too small to be commercially practical. Ramie fibre is being prepared from dry stalks in California, but this method cannot be used in a humid climate.—Annual Reports of the Department of Agriculture, U. S. A.

THE CATTLE INDUSTRY OF MAURITIUS.

According to Bulletin No. 1 issued by the Department of Agriculture, Mauritius, which contains details of the Animal Statistics for 1914 we find that the total number of cattle imported from Madagascar during the 5 years (1909-13) was 36,861 or an average of 7,372 per year ; while the total number imported during 1904-08 was 36,826 or an average of 7,365 per year. The imports of 1907 amounted to 11,598, the highest number of the period, while the record year was 1863 when some 14,557 were introduced. In addition to the above imports some 70 or 80 bullocks are annually imported from Rodriguez.

The total number of horned stock is 41,301, representing 112 per 1,000 inhabitants. This is a very low proportion if compared with that of countries like Australia, (2,655 per 1,000 inhabitants) or Madagascar (1585), or Denmark (814), or even with Ceylon (356), Netherlands (336), Fiji (321), India (298), British Guiana (276), Belgium (266), United Kingdom (262), Porto-Rico (233); but it compares favourably with Egypt (106), Japan (27), and Malta (26). However if the basis of calculation is taken per 1,000 acres of total area, the relative figures are Netherlands 252, Denmark 238, India 172, United Kingdom 151, Mauritius, Hungary, Bulgaria, Ceylon 90, Malta 76, Madagascar 34, Transvaal 18, Natal 20,Fiji 9·4, Australia 6·1, Egypt 5·5, Canada 2·8, British Guiana 1·4, Newfoundland 0·38.

The relationship between the numbers of cattle and the cultivated area shows that this colony, with a rate of 206·5 head of cattle per 1,000 acres of cultivated land, compares most favourably with other tropical countries.

The rate of increase of the colony's horned cattle is at the present time nearly 18 per cent. per year, which means that if the imports from Madagascar and beef consumption remain normal and no epidemics of disease occur, the total number of horned cattle will reach 65,000 in 1917. The ratio of cows to all horned cattle indicates the increase that is taking place in a country, and Mauritius (39·4 %) compares favourably with India (36 %) and the United Kingdom (37 %).

THE MANUFACTURE OF MATCHES.

In an interesting article contributed to the Wealth of India on the match-making industry in India, Mr. Evance the expert points out that in 1911-12 nearly 98½ lakhs of rupees worth of matches were imported into India, which is quite capable of manufacturing all the matches she requires. The necessary wood supply is available, such soft and otherwise useless woods as that of *Bombax* being abundant.

Mr. Evance reckons that a capital of 5 lakhs would be necessary to start the industry on a proper scale. He discusses all practical details such as machinery, management, etc., and comes to the conclusion that for the investment of 5 lakhs, which would lay down a plant capable of producing 2,000 gross daily, a profit of 40 % is pssible.

LEECHES IN MYSORE.

There are two kinds of leeches in the ghat area of the Mysore State which attack men. One of these Haemadipsa sp. (H. Zeylanica ?) shows the interesting feature of living on moist land, the other one, a much bigger form, living purely in fresh water. The following further particulars in addition to those given by Shipley (vide Tropical Agriculturist, Feb., 1915. pages 119-120) with reference to the habits of the leeches and the methods used in escaping their grip may be interesting.

The leeches begin to appear in ordinary forest areas with the early monsoon, say, about the beginning of June, and molest the travellers till the end of December. There are certain very damp and woody places where they persist throughout the year. They occur on decomposing vegetation, fallen trunks of trees, leaves of shrub jungle, such as Strobilanthi, and even on bare rocks. They stand erect on one end, and perform nutating movements. The first few occasions that they bite, one is not aware of their presence, but habit makes one fairly cautious and a sort of cold uncanny feeling in the leg is a sure sign of the presence of a leech. It is not quite correct to talk of persons being killed by leech bites ; because, many hundreds of coolies work in the area day after day and yet survive the bite.

Among the measures employed in escaping their attack, smearing the legs up to the knee with castor oil is a very effective one. Snuff, juice of sour limes, and slaked lime paste are also useful in getting rid of the leeches, especially the last, as it will stop the bleeding. If a man has passed through an area where leeches are known to exist, he will find it a useful practice to wash his legs in warm water. He can thus see any leeches sticking on to his legs and remove them as soon as possible.

The leech cocoons are usually found on the ground in the jungle and sometimes collected and destroyed but it is only to a very limited extent. The surest way to get rid of them is to put them in the fire.

Attempts to pull them off are not always the best, as inflammation sets in. As noted above, a drop of acid juice makes them drop down, and if one has pulled out the leech and suppuration sets in, a bandage soaked in solution of lead acetate and tied over the swollen portion is a very useful remedy.

M. K. VENKATA RAN,
Mysore Agricultural Department.

SUNFLOWER SEED.

There is nothing more easy to grow as a farm crop than sunflowers, but, apart from their ornamental character, one never thinks of these plants as being of any use to the cultivator. Although the plant has never been cultivated on a commercial scale in Queensland—except, as far as we know, by Mrs. H. E. Waller on the Binjour Plateau, Gayndah, about five years ago—there is no reason, except, perhaps, prejudice, why it should not be a staple crop for Queensland. Why it has been so long neglected by Australian farmers it is difficult to say, considering that it is grown to an enormous extent in Germany, Hungary and Russia, and the demand is always greater than the supply, notwithstanding the fact that each seed sown produces 1,000 or more, and the price ranges from £10 to £11 per ton. The most profitable sort to grow is the Giant Russian, of which each head contains from 1,000 to 2,000 seed, and even as many as 3,000 seeds per head have been harvested in Russia. The plant is admirably adapted to the soil and

climate of Queensland. It thrives as well in the dry West as on the Darling Downs and on the Eastern coast lands. It is not particular as to soil, but succeeds best on deep well-drained loam, whether scrub or forest or plain. It does well on maize lands; and as the plant needs a less rainfall than maize and is a much quicker grower, the crop requires less cleaning owing to its giving more shade, thereby lessening the growth of weeds, which means considerably less work to the farmer. From 4 lb. to 5 lb. of seed is sufficient to sow an acre at distances between the rows of about 3 ft. and in the rows about 12 in. to 18 in. from plant to plant. The return may be set down at about 50 bushels per acre. Sunflowers grow very rapidly, the crop being usually ready to harvest in three months.

The harvesting is a very simple matter. Mrs. Waller says that on ploughed ground a tip dray can be used provided with a frame covered with bag. The dray passes along the middle of the rows—one row on each side. The heads are cut and thrown into the dray. They are then driven to a convenient place in a paddock where there is a box, about 4 ft. high by 3 ft. square, with a wood batten nailed on about 9 in., from the top inside on which the heads are "banged," when all the seed which is fully ripe and good falls into the box. The seed is then winnowed. Two men cutting into the dray can keep one man threshing.

Mr. Henry A. Tardent, in a paper on "The Sunflower," published in the Queensland Agricultural Journal in October, 1899, said that "a very expeditious way to harvest it is to cut the stem close to the ground by means of a horse corn-cutter, and to cart home stems and heads together. The heads should be then dried as quickly as possible, and as soon as dry enough they can be threshed, winnowed, and bagged."

The seed is rich in oil, and yields 34 to 50 per cent.; while the oil cake forms an excellent food for stock. The best time to sow the seed is from September to February, inclusive.—Queensland Agricultural Journal.

INDIAN AGRICULTURE.

The subject of scientific agriculture is so important in India to-day that many will read with much interest the paper that Dr. Harold Mann presented to the Indian Science Congress on the "Development of Indian Agriculture." Among the many officers of the various Departments in India there could hardly have been chosen a better exponent of the subject, because of the length and extent of his experience of the conditions of Indian Agriculture. His service with the Indian Tea Association gave him an insight into the conditions of the planting industry, which has little to earn regarding the need for scientific agriculture. His service in the Bombay Agricultural Department has brought him into contact with that other kind of agriculture which is so often called the "backbone of India's prosperity"—a system described by Dr. Mann as "extensive agriculture conducted without much capital, with primitive implements and methods and yielding poor results when compared with any Western Standard." It is this branch of Indian agriculture that the formation of the Agricultural Departments is designed to improve. How poor generally are the results of the existing methods Dr. Mann was able to show by a comparative statement of the average acreage yields of certain crops common to India and other countries, such as wheat, cotton and sugarcane, though in the case of the last-named this is due to the miserable outturn from Northern India; that from Bombay and Madras is fairly up to the world's average. In dealing with the problem of development, Dr. Mann had some very interesting remarks to make on the proverbial conservatism of the Indian ryot which, it is alleged, has in the past

barred the way to progress. To those of us who have accepted this statement without much thought of the actualities of the situation, it will come as a surprise to learn that this conservatism is justified. "When a man," says Dr. Mann, "is working on a minimum capital when any excess of capital costs probably from 12 per cent. upwards for interest, when the money is turned over once, or, at most, twice in the year, it is only policy to be extremely conservative." Besides, any departure from this policy has so often been exploited in the past by the well-meant, if judicious, schemes of empirical agricultural advisers, that the only result was to harden the ryot's heart and to confirm him in his conservatism. But there are exceptions, and Dr. Mann records it as his experience that ryots are willing to follow an adviser who has gained their confidence in a manner that sometimes savours of rashness. According to Dr. Mann, the way in which to work for the future development of agriculture is to discover the primal need of the agriculturist—it varies probably according to the Province or place in which the adviser is situated —and then to work along the lines of least resistance. In the Bombay Deccan, for instance, the primal need is water to irrigate and bring to fruition the crops. Unless this can be supplied, it is useless to ask the ryot to adopt any of the methods of scientific agriculture to improve his outturn ; once it is supplied he is prepared to follow his adviser and adopt them, regard always being had to the fact that his enterprise is limited by his capital. We have not the space to follow Dr. Mann as he develops this theory ; but what he has to say of his experience and the results achieved is certainly convincing. Much of what he says applies equally well to agriculture in the non-deltaic or canal-commanded tracts of the Madras Presidency, and is the justification for the formation of the well-boring section of the Madras Department of Industries.—Indian Agriculturist.

PLANTAIN DISEASE.

Rev. FATHER M. J. LE GOC.

It is now over a year since a plantain disease spread of a sudden round Colombo. The young plants were arrested in their early growth; their tender leaves were withered as if a deadly blast had passed over them. Dr. H. M. Fernando was the first to draw my attention to this new malady, while Mr. C. Drieberg handed over to me for examination the last plantlet left in his Stock Garden by the new plague. Last September a whole row of plantations growing along the lake in St. Joseph's College were found wilting rapidly, exposing to the sun their dry and brown leaves which soon collapsed and decayed. Here I found, at home and in abundance, the very material required.

Microscopic sections across different parts of the leaves showed no particular infecting organism. The conclusion to be drawn was that the evil was lying either in the conductive or in the absorptive tissue. The roots were next examined. This revealed the presence of bulky brown spores, which were of frequent occurrence on different specimens; numerous hyphoe were running along the cortex which was in a visible state of decay, and finally, in the most affected material, threads of the fungus had passed inside the xylem, especially along the vessels, where they branched very freely. At this stage the fungus had not yet reached the stout rhizome, which forms the whole stem of the plantain ; but it is possible that the disease passes through the rhizome into the new off-shoot, although more likely the infection takes place along the ground by means of the spores which are produced in abundance on the surface of the roots.

From these facts we are able to infer that the plantain disease is a root disease. It affects at first the cortex, which is soon killed ; as a consequence the process of osmosis is stopped, the supply of water and of nutrient salts is arrested, the leaves soon become wilted and dry up and the plant dies before it is able to bear fruit.

The appearance of the hyphoe varies to a great extent : brown thick and septate threads are abundant in the cortex and protrude outside in swollen heads, while in the xylem the much-branched hyphoe are mostly very thin, colourless, and rendered clearly visible only by the use of stains.

The reproduction of the fungus takes place by means of several forms of spores. They have been found both on the roots of plantain and in the cultures made in liquid plantain decoctions and in decoctions solidified with 2 per cent. agar. On agar a brown layer of spores covered the whole surface of the culture, but there was also an attempt to produce aerial structures. Conidiophores bore on numerous stalks small oval-shaped hyaline conidia, which drop off as soon as they are formed, and never formed visible chains. 3-5 septate curved hyaline spores, falcate or somewhat crescent shaped, are frequent both in nature and in cultures. They are sometimes found in clusters in a mucilaginous envelope. Some of the hyphoe bear terminal brown bulky chlamydospores, and two-celled (Diplocladium stage) spores have also been observed. The fungus belongs to the genus Fusarium ; but my observations have not yet enabled me to determine the species with certainty. This genus offers such a variety of vegetative and reproductive stages that its identification and specification has led to much confusion. This is the reason why Fusarium has been given many different names. The literature I have now in hand is too limited to allow me to discuss this question at further length.

Fusarium is a well-known root disease, for instance, on tomato and other plants ; but, so far as I am aware, it has never been recorded on plantain. The plantain disease has no doubt been already investigated, but I have no knowledge that its nature has been determined.

The origin of this sudden outbreak of disease round Colombo is a question to which the readers would like to have an answer. It can perhaps be better explained by those who are engaged in its cultivation. Have new plants been introduced from outside the Colony? This is always a very serious question. The introduction of plants from foreign lands is also often the introduction of a new disease, and ought to be carried out under severe and careful control.

As the disease now stands it is seen to fare best in damp and badly-aerated soils. There is no direct remedy for a plant which is once affected, as we are dealing with a root disease. The only remedy to be applied is of a preventive nature. Good drainage is always a sound and healthy practice in agriculture. The burning of all diseased plants is an urgent necessity to prevent the multiplication and dispersal of spores. The sterilization of affected soils is an effective measure where feasible. A good safeguard is to avoid planting a new shoot in the place from which a diseased plantain has been removed unless sterilization has been effected.—Ceylon Medical College Magazine.

MINERAL FOOD OF PLANTS.

So far as our present knowledge goes, the food requirements of plants are surprisingly modest. Besides water, all they extract from the soil are compounds of nitrogen, phosphorus, sulphur, potassium, lime, magnesium, and iron. Hence it is not surprising that physiologists should from time to time ask the question, Do these elements satisfy all the complex requirements

of plants or are other elements, albeit in minute quantities, also necessary? The question is easier stated than solved: for there are many and formidable experimental difficulties to be overcome before a sure answer may be obtained. It is obviously impossible to seek an answer from the behaviour of plants growing in soil; for it is a well-established fact that just as jackdaws acquire and secrete in their nests any unconsidered trifles which come in their way, so plants may absorb in considerable variety and quantity many, if not all, of the mineral elements which occur in the soil. They may even to their detriment absorb poisonous substances. Wherefore it follows that the occurrence of this or that element in a plant is no index of its usefulness or indispensableness to the plant. Direct experimental investigation of the problem is difficult owing to the facts that, on the one hand, ordinary chemicals are by no means absolutely pure, and glass or earthenware in which plants are grown contains many different substances traces of which may pass into solution, and, on the other hand, a substance may be essential to growth even though the minutest traces of it are required.

Therefore, in order to carry out an experiment the utmost care must be taken to employ chemicals of absolute purity and to see that the plant used in the experiment does not serve, by way of the reserve food of its seed, to supply a sufficiency of these doubtful elements to the germinating seedling and to ensure that no substances derived from the glass receptacles in which the plants are grown or from particles of dust find their way into the plant.

The most recent experiments which have been made have been carried out by Mr. Maze with all possible precautions. They appear to show that with the Maize plant the above enumerated indispensable elements do not exhaust the list, but that to them must be added manganese, zinc, silicon, and cerium. It may be noted that the importance of manganese has long been suspected, that zinc is known to play curious tricks in the speeding-up of growth, and that silicon, according to some experiments, though not according to others, is essential for the growth of cereals. Furthermore, although the Maize plants developed and set seed when all the elements of the two lists given above were present, this was only the case when spring-water was used. When spring-water was replaced by distilled water purified by repeated redistillation even this lengthy series of elements did not suffice for complete development. The failure of the crop was traced to the absence from the distilled water of compounds of boron, aluminium, fluorine and iodine, traces of which were found to occur in the spring-water.

Whether these remarkable conclusions apply to other plants or whether they are peculiar to Maize is not known. On general grounds we may be fairly sure that if the conclusions hold good for Maize they will also be found to apply to other plants as well.

Nor should anyone hastily conclude that facts such as these are of academic interest only. They may well prove to be of economic value as well. For example, the presence or absence of traces of one or other of these supernumerary elements may exercise, for all we know to the contrary, a decisive influence on the immunity from or susceptibility to disease. It is therefore to be hoped that the all-important question of the complete dietary of the plant shall be established on an indisputable experimental basis.—Gardeners' Chronicle.

SWEET SORGHUM FOR SUGAR.

H. E. ANNETT.

From time to time attempts have been made to grow sweet varieties of sweet jowar *(Sorghum sp.)* for the purpose of sugar production. The seed has in many cases been imported from America, but in certain parts of India local varieties are found which contain much sugar.

The experiments here described were made at Lyallpur and at Gurdaspur, Punjab.

At Lyallpur a local variety was grown. It was sown on July 26th at the rate of 12 lb. per acre, without manure; the ground was irrigated four times. In order to determine the best time for the harvest, the whole plot was divided into 20 equal sections which were gathered two at a time at 10 different intervals. From every lot the juice was boiled down. The best results were obtained from the sections cut towards the end of October or beginning of November. The lot cut on November 9 yielded 6 tons to the acre of stripped cane with 6,587½ lb. of juice, and from this 875 lb. of raw sugar (gur), or 13·3 per cent., containing 57·90 per cent. sucrose and 13·42 per cent. reducing sugar, were obtained. This is quite a poor quality gur.

From the results of the Lyallpur and Gurdaspur experiments it appears that as a source of sugar, saccharine jowar is not worth growing in India. Even in America it is only grown to make syrup, for which there is a demand in that country, while there is none in India.

The high glucose ratio of the juice militates against the production of good crystalline gur. The juice contains also substances which produce, at times, a very objectionable taste in the gur.

The yield per acre obtained from a very good crop of sorghum only worked out at about 8 cwt. per acre. Hence the yield of sugar per acre would be only about one third of that from the average country sugar-cane crop.

These results tally with others obtained previously at Poona with the Collier and Amber varieties, which yielded 1174 and 1072 lb. of molasses per acre respectively.

The experiments made by the writer indicate that the total sugar content of the crop is highest when the seed contents begin to dry. Thereafter until the seeds are dead ripe the total sugar in the crop decreases, but the decrease is mainly at the expense of the reducing sugar. As the plant approaches ripeness the amount of juice expressed from it decreases.

As a source of fodder saccharine sorghum seems valuable. The crop is fairly quick-growing, as has been seen, and yields abundant green produce. After the seed is in the thin milk stage no increase in total weight of the crop takes place and also the amount of total sugar in the crop has almost reached its maximum. Hence, when being cut for fodder, the crop should not be allowed to get beyond this stage.—Monthly Bulletin.

ON HARVESTING AND CURING TOBACCO.

C. J. TREGENNA.

Maturity will be reached some three to five weeks after topping. The varieties which have been distributed by the Department this season, and which have been planted under suitable conditions, should show lighter shades of green as it reaches maturity, a golden sheen being noticeable when the leaf is inspected in certain lights, and in some cases a yellowish blotchy discolouration or yellow spots. When folded between the fingers the leaf should crack across and not merely leave the mark of the fold.

The method at present adopted in the State is to harvest the whole plant together. A much better one is that known as "priming," which consists of harvesting the leaves as they mature, for the whole of the plant does not ripen at the same time. Where the more common method is practised a fine discrimination must be exercised in order that the largest proportion of

leaves on the plants shall be cut at the right stage ; as a rule it will be found that the plant should be cut when the middle leaves have matured. A combination of the two methods will give satisfactory results, and is recommended. When the bottom leaves have matured they should be primed off and strung, and the upper leaves could be left until they are ready, when they could be taken off with the stalk as in the case of harvesting the whole plant.

Where securing is effected by means of an open shed, as is the present custom in this State, the tobacco should be cut late in the afternoon and hung on the sticks close together. When it has wilted it will be possible to pack closer without damaging the leaves until they have assumed a yellow colour. When this change has taken place each stalk should be separated by a space of six inches and the sticks removed to the barn, where the distances apart should not be reduced. Growers should note that sticks, when in the barn, must have sufficient space to allow of a free current of air ; crowding the leaves together in the shed is a great mistake. Tobacco that shows every promise on the scaffold of curing a good colour is often spoilt by neglect of this precaution, and the result is a dark dingy-coloured leaf.

You may pack your leaf very close on the scaffold, but give plenty of room on the stick and between the sticks when hanging in the shed.—Agricultural Gazette, N. S. W.

CLEVELAND FLY CAMPAIGN.

The scientists the world over now know that the housefly is the most dangerous enemy of mankind. Just how many people are killed in Cleveland by fly-borne diseases is not known and never can be known until we completely rid our city of the pests. We do know this, that only four out of every five children born in Cleveland live to be five years of age. It is a common thing to hear parents remark, "I don't know where my child got that disease. We have been so careful." The chances are that the answer to that parent's query is "flies."

But many will say, "We have no flies in our house." This may be true, but no one is safe from fly-borne diseases so long as our dairies, markets and provision stores are swarming with flies.

The Anti-Fly Campaign was inaugurated in Cleveland to do away with all this sickness and death. That it can be done is shown by the work in Panama. France failed at Panama because so many thousands of her men lost their lives through disease. This country has succeeded because we have practically rid the Canal Zone of mosquitoes and flies. To-day Panama is safer to live in than any city of the United States. We can make Cleveland equally safe, if we will do four things :

1. Kill all the flies that survive the winter, as soon as they appear in the spring. These are the mother flies, few in number, but responsible for all the generations that infest the summer. One fly killed at this season is equal to killing millions in August or September.

2. Be sure that no flies either feed or breed on our premises. This must be our universal rule, forever. In the best of homes we have records of garbage cans that have neither top nor bottom.

3. We need to have some kind of a fly trap set in our back yards so as to catch all the flies on their way from their breeding places to our homes.

4. Realizing the dangers of the housefly, we must cease to trade with dealers who permit flies to swarm in our dairies, restaurants, markets, and bakeries. By withdrawing patronage from the careless dealer, we can put our fly campaign on a dollar and cent basis. This will line up all dealers in food stuffs on the

defensive. They will in turn demand that all places where flies may breed in their neighbourhood be cleaned up. Then we will have not only a flyless but a really clean Cleveland.

Did the people respond to such teaching, you ask? Did we get tangible results? Was the campaign a success? A small volume might be written in answer to these questions, instead of the brief space left. Perhaps the best means of judging the degree of success or failure of a movement of this nature is to get the attitude of the commercial world. Good business men are keenly alive to the slightest change in the public pulse and act accordingly. To illustrate: When we went to the aid of the proprietor of a large, down-town restaurant this summer, the man made this very significant statement: "You see, since the city has been so stirred up about flies, we can't afford to have them about. It was only yesterday that an old gentleman, for years one of my best customers, told me how they hated flies in his home. He said that he and his wife would chase a fly all day and wouldn't rest until they had killed it. Now, you know," the keeper of this restaurant added, "I can't hope to keep a customer like that if I have flies about."

Strange as it may seem, the business world held out a helping hand far more eagerly than the domestic world. Indeed, the average man seemed to attach far more importance to the control of the housefly than the average woman.

We are encouraged to do battle afresh when we hear words of appreciation such as were uttered by a member of a delicatessen firm, whose name in Cleveland is synonymous with quality. "You will never know the amount of good the Anti-Fly Campaign has done for this city. All summer our down-town store has had no more flies than during the winter months, and I have noticed restaurants and meat markets that are as free from flies as we are."

The amount of typhoid fever has been greatly reduced in Cleveland during the summer. Perhaps, the reduction, at least in part, is due to the war on the fly; all open vaults were screened and bushels of flies were trapped and killed in the markets and provision houses.—Fiji Planters' Journal.

ORIGIN OF CULTIVATED RICES.

AUG. CHEVALIER AND OLIVIER ROEHRICH.

The extensive geographical distribution of cultivated rice and the antiquity of its cultivation have prevented botanists from determining whether the numerous varieties are derived from one common type or from several, as well as from discovering precisely in which country they originated.

The wild rices of Asia, except one found in Indo-China by one of the writers, are distinct from the cultivated varieties. This exception shows no specific differences from cultivated rices and is probably the original species from which all the varieties of the species *Oryza sativa* have been derived.

Four wild species distinct from *O. sativa* have been found in Africa. Nevertheless one of them appears to belong, if not to the original type, at least to a type very similar to some varieties cultivated exclusively in West Africa, and which is often found amongst the crops of the typical rice introduced from the Middle East by the Portuguese some centuries ago.

The five principal species studied by the writers are as follows:—

(1.) *O. latifolia* Desv. *O. punctata* Kotschy. The species *O. punctata* of the Egyptian Soudan is identical with *O. latifolia* of India and M. Chevalier found that it occurs also in Dahomey.

(2.) *O. breviligulata* A. Chev. et Roehrich, = *O. Barthii* A, Chev. *pro parte :* occurs wild in the regions of the Soudan (French Nigeria) inundated by the Niger and in the swamps of Baguirmi. A certain number of wild rices of Central and Western Africa are related to this species, and only differ from it in a few characters. Some of the cultivated rices of West Africa are also related to this species. *O. glabberrima* Stend. is a variety of these cultivated rices, of which some show also a second variation of long glumes.

(3.) *O. brachyantha* A. Chev. et Roehrich. = *O. Barthii* A. Chev. *pro parte :* in the Western Soudan and Egyptian Soudan.

(4.) *O. longistaminata* A. Chev. et Roehrich = *O. Barthii* A. Chev. *pro parte.* Perennial rice with rhizomes, largely distributed throughout tropical Africa (Senegal). It is the perennial rice of Richard-Toll found by Ammann. It is found growing with other wild rices in Nigeria, Baguirmi, Chari, Egyptian Soudan, Tanganyika, and the Belgian Congo.

(5.) *O. sativa* L. (*sensu lato*). occurs wild in Annam, Cochin-China and Cambodia, on lands flooded during the rainy season and in rice fields which remain wet after the harvesting of cultivated rices. It is considered as a weed by the natives. —Monthly Bulletin.

AGRICULTURAL EXPERIMENTS IN MADRAS.

SEEDING AND MANURING OF PADDY.

. The reduction of the seed-rate for transplantation of paddy has been so consistently and regularly advocated that there is no need to refer to it at any length here. The whole of the wet land area at Coimbatore over 40 acres was transplanted from 2·11 acres of seed-bed on which 730 lb. of seed had been sown. This works out practically to 16 lb. of seed for each acre transplanted, whereas if the ordinary local practice were followed 106 lb. would have been used, and the returns from the land have not decreased.

The average yield over the whole 40 acres of wet land area of the central farm was 2,572 lb. of grain as compared with 3,762 lb., the highest revealed on ryots' land in the crop cutting experiments, at Samalkota the average over a similar area was 3,037 lb. as compared with 2,390 lb., the highest figure recorded for ryots' land in the Gōdāvari this year.

Considerable attention is being paid at Samalkota, Coimbatore and Manganallur and, to a less degree at Palur to the questions connected with the manuring of paddy. It may almost be accepted now that the most suitable form in which to apply nitrogen to paddy is in organic combination, whether as green manure or as cake. It is in one of these forms that nitrogen is now always applied on the farms to this crop. It is unfortunate that the wet lands at Coimbatore are so unsuited for experimental work, as it requires much repetition there before results can be accepted with any certainty. But the results of five years' continuous work at Coimbatore, nine years at Samalkota and one year at Manganallur are all in substantial agreement. At Samalkota an average increased yield of 810 lb. of grain per acre per year over nine years has been obtained by applications of castor-cake plus superphosphate; at Manganallur an average acre increase of 630 lb. of grain has been obtained by an application of green leaf plus superphosphate; at Coimbatore a complete manuring with an extra dose of superphosphate has given an increased average yield per acre of 660 lb. per year over five years. The results are also in accord with chemical analyses of the soil. In all these cases also the increase in the yield of straw has been greater proportionately than the increase in the yield of grain. A careless observer using

these manures might think that all the manure was going into the straw; yet these figures show that the increase of grain is decidedly appreciable. It would not be reasonable to push these figures too far as many questions connected therewith, e. g. on the financial side, on the form in which to supply phosphate, though so far all indications point to the use of superphosphate, require to be worked out. If the prices of paddy continue to rise a little more the extended use of such fertilizers should become a matter of regular business for such land and crops.

GREEN MANURING.

Considerable interest will, for some years, circle round the action of green manuring, since there are many problems connected therewith not as yet understood. Of all the essential elements which a farmer in the west buys for manurial purposes it is nitrogen which is the most expensive, but generally speaking paddy cultivated under swamp conditions utilises nitrogen presented to it in organic combination much more thoroughly than when in combination with minerals. This is most fortunate for the tropical farmer, for green leaf and green manuring are much cheaper than nitrates, etc; in fact there is no comparison, but it is also obviously more difficult to grow and manage a green manure crop than it is to distribute over a field a certain number of pounds of nitrate. Thus it was reported last year, that on the heavy delta soils at Manganallur the application of a green manure crop in the ordinary way on these fine soils had temporarily interfered with the drainage and the paddy crops had failed. Mr. Sampson had surmised that in this year the fields would probably show the benefit of the green manure crop they had received; consequently no further manure was given to them The figures are so striking as to merit repetition in full :—

PADDY YIELD PER ACRE IN POUNDS.

Field Number.	1911—12 Treated in the ordinary method prevailing in Tanjore.	1912—13 Green manure applied, crop failed.	1913—14 No further manure added.
1	1,149	205	2,251
2	1,066	164	2,332
3	1,206	253	1,963

Other experiments were laid down to try other methods of managing the green manure but, while none of the paddy crops have failed yet, the results are too inconclusive at present to draw any inferences. The general effect of seed selection and green manuring in maintaining the fertility of rice land is indicated from the figures of Palur, which station was opened in 1906-07. The average yields of paddy per acre over the whole farm in 1907-08 and in 1909-10 and in each succeeding subsequent year have been 1,777 lb., 1,751 lb., 2,791 lb., 2,838 lb., 2,934 lb., 2,689 lb., and in the latter years as it has all been transplanted with single seedlings another 70 lb. per annum per acre have been saved in seed. The last year was not a favourable one on account of the floods.

GROUNDNUTS.

Work on this is mostly confined to Palur, where some 13 varieties have been regularly cultivated for some time and cultural experiments have been in progress. This work is likely to become immediately important once more, as with the boom in groundnuts the area under this crop has expanded very rapidly and with it complaints have come from Marseilles of a steady deterioration in the percentage of oil. With ordinary careful cultivation this ought to be impossible. It is wrong to cultivate groundnuts as a pure crop year after year on the same soil. Experiments have now been in progress at Palur comparing the results of growing groundnuts regularly on the same land or of growing it mixed with a cereal *tenai* or *cumbu*, or alternating it with

these cereals. On the latter plots neither has the total crop yield of groundnut decreased nor the oil content deteriorated—it still gives 49·84 per cent. of oil as a rain-fed crop as compared with 46 per cent. in 1906 and 48·8 per cent. in 1907, and in addition these plots show an average annual money profit over seven years over the pure groundnut crop of Rs. 28, Rs. 35, and Rs. 38 per acre. A considerable amount of knowledge is being obtained about the 13 varieties which are regularly being grown at Palur and they are becoming acclimatised so that they will be ready in case of need, but while some of them, especially a Barbados variety and West African, are promising, Local Mauritius when properly cultivated maintains an uniformly high position in the list. This is partly due to the high percentage of kernel to nut it possesses. In other varieties there is greater proportion of husk. But on account of the complaints from Marseilles more attention will be again paid to groundnut this year. It is not merely a question of seed, the method of shelling also affects the ultimate product.

SORGHUM.

Most work in the way of selection is in progress at Hagari where the object in view is not only to get a heavier yielding strain but also, if possible, to get that on a plant with a dull grey midrib along the leaf. It is found that there are two well marked lines, one in which the midrib of the leaf is dead white in colour, is pithy and does not make succulent fodder, the other in which the midrib is a dull grey, is a sweeter plant and gives better fodder. The results are not complete yet and some of the seed selected had obviously been cross-fertilized because in one case at least the resulting plants split up on true Mendelian lines. At Koilpatti and Coimbatore, Periya manjal cholam sown thickly formed an excellent fodder crop. At Coimbatore the land had been carefully cultivated and in spite of the dry weather an average yield of 670 lb. per acre was obtained from the dry land. Seed for trial in subsequent years was selected from some of the plants which had most obviously resisted the drought best.

PEPPER.

The crop was on the whole good and the total yield was the highest ever attained at Taliparamba, viz., 3,926 Madras measures of green pepper. Of the various manurial plots the one treated with lime and leaf mould continues to give the best results and improving ones. From $5\frac{3}{4}$ Madras measures of pepper in 1906-07 it steadily increased to 113 in 1911-12, to 140 in 1912-13 and last year reached $217\frac{3}{4}$ Madras measures. Some of the younger vines which had been planted to replace deaths are now coming into bearing but the best testimony to the efficacy of this treatment is afforded by the uniformly steady improvement in the average yield of the old vines, viz., from ·05 to ·24 Madras measures per vine in 1906-07, and 1907-08 to ·66 and ·79 Madras measures 1912-13 and last year. The only other plot which shows a constant improvement in the average annual yield of the old vines is the one treated with cattle manure, which has progressed more slowly and irregularly. Whilst shade is essential for the growth of pepper it not infrequently happens that the live Murugu standards which are the ones mostly used die before the vines cease bearing. Consequently an attempt has been made to train vines on dead standards under shade. They are just coming into bearing and are promising well. It is somewhat difficult in a West Coast garden to get uniform plots at all suitable for comparing different varieties, but the best arrangements possible were made and the three main West Coast varieties, viz., Utterankotta, Balamkotta, and Kalluvalli are being grown against each other. The Balamkotta vines commenced to yield first but the Kalluvalli are now overtaking them in yield per vine. The Utterankotta which is a purely female vine is naturally lagging behind. It has to rely on stray pollen for fertilization.—Report of the Director of Agriculture, Madras Presidency.

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Photo by H. F. Macmillan.

HARVESTING THE PADDY CROP.
(Rubber and Coconuts in Background).